THE AEROPLANE

Incorporating
Aeronautical Engineering
Edited by - - THURSTAN JAMES

Founder and First Editor
(1911-1939), C. G. GREY

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LOOKING FORWARD

OLD customs die hard. And one of England's hardiest is that of looking nostalgically back at the good old days. We cannot think that the year which is passing is likely to rank for inclusion in the good old days of aviation, so there is no good reason to indulge in overmuch looking backwards. Let us remember that the present is what we live in and the future is what we have to worry about. The decisions that are made today or, what is much worse, not made, are what are going to determine the shape of our future. In spite of superlative aircraft export figures, the writing is already discernible on the wall. One of the most famous names in the aircraft world, that of Supermarine, is destined to lapse with the passing out of production of the Scimitar. It needs no biblical seer to discern an equally unpromising future for other famous names.

It is true that the planners have finally decided that the Royal Air Force is to have a "Canberra replacement" as the aircraft specified in the so-called OR.339 requirement has been loosely described. However, the design and building of the prototypes for this can scarcely be expected to occupy the efforts of many factories or of many thousands of workpeople.

In the civil field we have the Viscounts and Britannias and Comets in production. Coming up closely behind are the Argosy and the Vanguard. Indeed it is confidently expected that the latter will have flown before 1958 is dead. Behind them are the VC.10 and D.H.121.

On the military side we have the Hunters being turned out in quantities for our overseas customers. We have the Sea Vixen and the Scimitars still coming off the lines. There is talk of the Gannet III for the Royal Navy. The Blackburn NA.39 is in production. The Lightning is beginning its life for the R.A.F. In the heavy field there are the Vulcans and Victors, which it has been decreed are the last of the bombers, for their place is to be taken by the missiles.

In the missile field we know that the Seaslug, Bloodhound and Thunderbird are in production. There is also the long-range ballistic missile Blue Streak. Beyond these types there is silence. In spite of talk among scientists there has been no official announcement regarding plans for Great Britain to take its place among the nations that are pushing out their probes into space.

Speaking last week, Mr. E. C. Bowyer gave some impressive figures for the British aircraft industry. He said that at present over 300,000 people are relying on the aircraft industry for a living. It is difficult to believe that these figures can be maintained on the programme which we have outlined.

In the helicopter field the way ahead has not been clearly charted and the difficulties that occur to be surmounted have been made plain by the history of the Rotodyne; here we have an aircraft for which a rosy future seems evident, yet its development has been held back continuously by lack of Government decision.

The industry is going through a pretty strenuous weight-reducing course. Is it not time that the Government Departments which have a finger in the diminishing aviation pie should also undergo slimming treatment? At the moment the Ministries of Defence and of Supply, the Admiralty, the Air Ministry, the War Office and the Ministry of Transport and Civil Aviation all have limited and often overlapping responsibilities in the aviation field. Yet none of the six has an overall responsibility for planning the future.

If, as is still the officially announced view, the R.A.F. is to give up fighters and bombers after the obsolescence of the rising generation, it will nevertheless always need aircraft for tactical wars and for transport. The Navy must have aircraft as well as missiles. The Army needs air transportation, it needs air observation posts. And how it needs helicopters!

Look at the map. Ask yourself how you move troops and supplies among the countries of the Commonwealth unless you have a very long-range aircraft with a payload of from 20 to 30 tons. No strategic planner today would dare (or we hope would not dare) to plan any operation in which the maintenance of supplies depended on finding bases within 250 miles of each other or on routes which depended on the acquiescence of countries outside the Commonwealth. The coming of the Britannia will help, but in no wise lighten the problem.

Nowhere discernible except in the meetings of a committee or two is there any acceptance of responsibility for the fact that the future of our industry must depend upon proper steps being taken now towards the gathering of data and of the necessary experimentation towards the eventual putting into hand of the supersonic airliner and transport.

As the year dies and we salute a new year, let all concerned with the business of British aeronautics vow to press for a concerted planned attack on the air potentialities within, and beyond, the air envelope of the Earth.

MATTERS OF MOMENT

No Barrier to Air Progress

AS the reviewing officer at the R.A.F. College, Cranwell, on December 16 for the passing-out parade of the 74th Entry of flight cadets of the General Duties, Equipment and Secretarial branches, Air Marshal Sir Richard Atcherley, K.B.E., C.B., A.F.C., has completed his last official appearance at the College's graduation parades. Retiring from the Service in March of next year, when he will give up the appointment of A.O.C.-in-C., Flying Training Command, Air Marshal Sir Richard Atcherley has, apart from a visit to Karachi early in 1959, no further official ceremonies scheduled at the present time.

By attending the passing-out parade last week at the College, where he graduated in 1922, the Air Marshal became the first officer to review an entry of flight cadets which included navigators and presented for the first time the Institute of Navigation Trophy and Air Ministry Prize for Navigators; the award went to S.Flt.Cdt. D. R. W. De Garis.

In his address Sir Richard commented on the false prophecies of barriers to man's progress in the air that he had seen swept away during his R.A.F. career. "Wing flutter, the sound barrier, the thermal barrier, even that old chestnut, the limitation of the human frame—all have been dispelled—and now it is the so-called 'ultimate' weapon. In every instance the pilot has passed on, unheeding in his insatiable quest after progress. But these alarms have cost this country very dear in terms of precious time and lost opportunity in this vital global race for technical supremacy in the air."

The Air Marshal believed that sooner or later the Americans would succeed in their attempt with the X-15 research aircraft to break out into space after circumnavigating the globe in orbit, and re-enter the atmosphere to return to their base in the Mojave desert. That day, he considered, would be a milestone with as profound an influence on life as Bleriot's crossing of the Channel had been.

"One other thing seems sure to me," he added. "Although the ballistic missile is a great technical achievement and has a very important rôle to play in the modern mixed arsenal, especially as a replacement to the bomb and the gun, this latest advance will make it, as a so-called ultimate weapon as 'un-ultimate' and dated as all its predecessors. For surely we must know by this time that, with God's will, there is no ultimate weapon and no barrier to man's achievement in the air."

Principal prizewinners at the graduation ceremony were S.U/O. T. V. Spencer who received the Sword of Honour; S.U/O. D. G. Lucas, the Queen's Medal; S.U/O. J. N. Puckering, the Philip Sassoon Memorial Prize, the Abdy Gerrard Fellowes Memorial Prize, the Hicks Memorial Trophy and the J. A. Chance Memorial Prize; and U/O. J. Delafield, the R. M. Groves Memorial Prize and Kinkead Trophy.

MISSILE MOBILITY.—A complete English Electric Thunderbird surface-to-air weapon unit was taken to the NATO guided missiles display at Paris last week. The weapon is described as a Thunderbird Mk. 1 and the mobile unit, seen here en route for Paris, comprised a launcher control post; launcher loader trolley (carrying the missile); a sensitivity test vehicle; a workshop, and a mobile launcher.

Lightning's Thousand Flights

STEADY PROGRESS with production of the English Electric Lightning has been reported in the company's annual review of its activities for 1958. All the prototype aircraft have been completed, it says, together with a "significant" number of the 20 pre-production aircraft. During the year, the company received an order for a two-seat operational training version of the aircraft.

More than 40 different pilots have now flown the Lightning—they included two members of an official U.S.A.F. evaluation team, and Peter Twiss of Faireys and Derek Whitehead of Blackburn and General Aircraft. Development flying of the aircraft continues apace at Warton and we hear that more than 1,300 flights have been made to date with P.1s of various sorts.

There have already been reports of the successful launching of Firestreak air-to-air guided missiles from the Lightning and the firing of its Aden guns. This suggests that the development programme has reached the stage where the weapons systems are being brought more closely together. If this is so, it would appear that the normal flight envelope phase of the test programme has been completed.

During the year three new Canberra variants made their début. Two of these—the PR.9 and the U.10 pilotless target version of the B.2—came from Short Brothers and Harland in Belfast, while the third—the T.11, a modified Canberra B.2 for training Fighter Command crews in the use of airborne interception radar—came from Boulton Paul Aircraft at Wolverhampton.

The review also has something to say about the range of aircraft equipment produced by English Electric. This seems to be an expanding part of the company's aviation business and mention is made for example of further substantial contracts for constant speed drives and main generating and control equipment used in the V-bombers. Another useful order has been for a generator specifically designed for the Hunting Jet Provost; this brings the total number of aircraft types fitted with English Electric main generating and control

FIRST FLIGHT.—The second prototype Handley Page Dart Herald making its first flight at the company's Woodley aerodrome on December 17. It was flown by Sqn. Ldr. H. G. Hazelden, Handley Page's chief test pilot.

equipment to five—the Bristol Type 192, Vulcan B.2, Canberra, Lightning, and Jet Provost.

The company's 40-kVA. air-cooled brushless alternator for high-altitude operation is still under active development. Prototypes of this unit were first run during the summer and they are now reported to have undergone several hundreds of hours of test running to date.

Among new lines of development the report mentions an investigation connected with control gear having no moving parts and using transistors and transductors in place of relays and carbon-pile voltage regulators; this is still undergoing research and development. And an "exceptionally small" motor has been developed for a new series of miniature rotary and linear actuators for guided-missile control-system applications.

Also in the guided missile field are the company's high precision gyroscopes for inertial navigation systems. These are made under licence from the Minneapolis-Honeywell Regulator Company of America—an agreement that the review describes as "probably the most important event from the commercial aspect."

Of Thunderbird developments nothing is said. It has been reported, however, that deliveries of these weapons are already being made to the Army. And although, during the year under review, the Royal Air Force cancelled their initial order for Thunderbirds, training of R.A.F. personnel is still going on at the company's Stevenage factory.

Looking at the Future of the Industry

INVITED to address the Students and Graduates of the R.Ae.S. in London on December 8, on "The Future of the British Aircraft Industry," Mr. E. C. Bowyer, director and chief executive of the S.B.A.C. said that this suggested title was too ambitious. Speaking as an individual, he would, however, attempt to assess the present state of the industry and to indicate various trends. Extracts from his talk follow.

Today the S.B.A.C. has 30 Ordinary Members, by which are meant companies engaged in the design and manufacture of complete aeroplanes, complete aero-engines, complete guided missiles or of complete propulsion units for guided missiles. It has 536 Associate Members, who manufacture literally every detail of equipment, component and accessory that go into aircraft or guided missiles, as well as the special steels, light alloys and many other materials of which they are made, and the fuels they consume. There are also 6 Ordinary and 16 Associate Members in the Commonwealth overseas—evidence of the industry's expansion outside this country.

The Society's Memorandum of Association was written early in 1916. It was obviously compiled by farsighted men, because it defines the Aircraft Industry as including the design, development and manufacture not only of all kinds of then known flying machines and aeronautical apparatus, but "all or any kind of machine for traversing the air." This obviously includes guided missiles and, in time to come, space ships; even they must traverse the air at some period of their journey.

Fortified by the Memorandum of Association, and also, of course, taking account of the practical problem, the Society decided more than five years ago to bring in guided missile manufacturers and the appropriate power unit manufacturers into full membership of the organization. Today the Guided Weapons Division, particularly on the technical side, is as active as its old-established aircraft counterpart.

What is the importance of this industry to the national economy? How many people does it employ? What is the size of its export trade, and could we do without it? The Aircraft Industry is among the larger employers of labour in British engineering. Latest available figures show that 247,500 people are at work in the industry on the design, development, manufacture and repair of aircraft (including engines)—18,000 less than the post-War peak of January, 1957. Of these, 200,000 represent the manufacturing side of aircraft and engines—8,000 fewer than in January, 1957. Shipbuilding and repair employ 201,000; the manufacture of motor vehicles and their repair, just over 600,000; wireless apparatus and gramophones, 131,000; machine tools, 113,000; and locomotive manufacture, 73,000.

It is difficult to estimate accurately the numbers of people employed on aircraft business in the ancillary industries, by which are meant the design, development and manufacture of instruments and other components and of the special materials which make up the aircraft and engine structure. However, a fair assumption is that between them these people make up another 30% of the total engaged on manufacture and repair of aero-engines; that is to say, approximately another 80,000 hands, making an aggregate total engaged overall in the Aircraft Industry of about 330,000. Nor does

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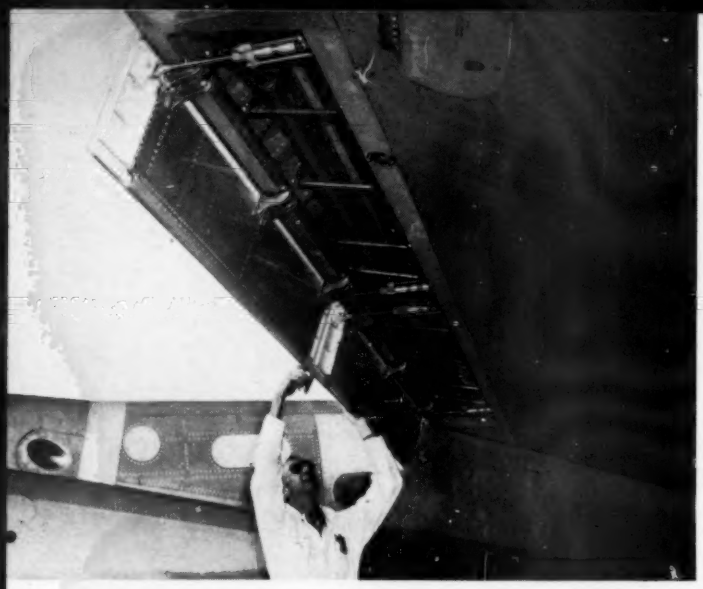


BOEING FLAP.—Opened here manually for inspection, the small leading-edge flaps of the Boeing 707 come into operation automatically when the trailing-edge flaps are lowered to 9°. Located just inboard of the outboard engines, the flaps ensure that most of the local airflow is forced up over the wing to reduce separation and increase lift at high angles of attack.

this figure include all of those engaged in the design, development and, soon now, the manufacture of guided missiles. It follows that not fewer than one and a quarter million men, women and children in this country today depend for their livelihood upon the Aircraft Industry.

The industry's contribution to export trade is a notable one. We shall export this year about £150m. worth of products, excluding licence royalties, or 11% of the nation's engineering exports. This will be about 30% more than in the previous record year of 1957. We export a modern aeroplane for around £15 sterling for each pound of structure weight, and an aero-engine for £17 to £18 sterling for every pound of weight. We export motorcars at something between 5s. and 10s. per pound of structure weight, implying a great proportion of material in the finished product.

Our present export achievement is the end result of much research and development done in the past, the greater part of it in the design and development of new types of Service aircraft and aero-engines. Our export trade has been living, and is living, on that work, and here we have one outstanding reason why research and development must *not* be allowed to sag. It is the life blood of future export business.

Without taking for one moment the line that the Aircraft Industry is wholly in the hands of the Government and without Government help cannot do a thing, the industry is entitled to ask for certain help and information from the Government, first because it is dependent on the Government for help on research and development and, secondly, because every manufacturing business must have sufficient information from its main customer to be able to assess the future trends of its business.

First need, Mr. Bowyer said, is the continuance of Government-sponsored research and development on a scale comparable with that of the past few years, and there the industry is looking for the full implementation of the Minister's assurance given a few months ago. The next requirement which may legitimately be placed before the Government is that there is no more delay in the issue of specifications for certain of the new types of manned aircraft which remain foreshadowed in the Defence White Paper; this is vital if essential design and project teams are to be kept together. Thirdly, the industry looks for a dependable indication of the size of the Government order-book for aircraft and guided missiles for as far ahead as possible.

The notably high level of export trade achieved by the industry during the past two or three years is the end product of research and development work done several years ago, and continuance of satisfactory export business depends essentially on continuance of research and development at levels comparable with those maintained in the past, though nowadays with the emphasis directed to the guided missile and the civil aircraft rather than to the high-performance manned combat aeroplane. Our export trade cannot continue without an adequate and imaginative research and development programme not only because of the urgent and expanding demand for new knowledge, but also because of the cost involved in development of the modern aero-engine and eventually of the supersonic airliner.

A New Aircraft for the R.A.F.

AFTER months of speculation—inspired and otherwise—the matter of a new aircraft to replace the R.A.F.'s Canberras has at last been resolved. Last week in a written reply to a question in the House of Commons, the Secretary of State for Air stated: "It has been decided to develop a new strike/reconnaissance aircraft as a Canberra replacement. This will be capable of operating from small airfields with rudimentary surfaces and have a very high performance at all levels."

The brevity of this statement would seem to be in inverse proportion to the importance of the project. And although it puts an end to all the speculation concerning the fate of the Air Ministry's OR.339 specification and the possible use by the R.A.F. of some version of Blackburn's naval N.A.39, there is still much conjecture as to the form the new aircraft will take and, perhaps even more important, who will make it.

The Minister's statement gives little away concerning either of these questions. However, his use of the phrase "very high performance" and the nature of the requirement leaves little doubt that this will be a supersonic aeroplane in the Mach 2 category. Clearly it will need to be a twin-engined aircraft and the most likely powerplants would seem to be two Bristol Olympus turbojets or a pair of Rolls-Royce R.B.142 by-pass engines.

Emphasis on high-speed operation at all altitudes indicates a somewhat difficult specification to meet and there is no doubt that this new aircraft will be of advanced design making full use of new structural and aerodynamic developments. Similarly, the degree of versatility required is made clear by the statement that operation from small airfields with rudimentary surfaces will be possible.

This last-named suggests that the aircraft will have STOL, if not VTOL, capability. If this is the case one would expect that some form of deflected jet efflux system is used rather than the installation of special direct lift engines.

It has been common knowledge for some considerable time that a number of companies had submitted designs to the Canberra replacement specification. No clue has been given as to the arrangements that will be made by the Ministry of Supply for the detail design and building of the R.A.F.'s new aircraft. However, it is quite clear that this will not be undertaken by any one concern but will be a co-operative effort between two, or even more, major companies. In this connection there have been strong rumours of a joint English Electric/Vickers-Armstrongs operation. And there has been talk of a Hawker Siddeley Group proposal centred around a design from their Aviation Division.

In both these cases a third member would be the engine manufacturer concerned and the large and comprehensive resources necessary for such a project would be available. But whatever consortium finally gets the order, the aircraft industry at large will benefit from the stimulus given by the proposal to go ahead with this new design for a very advanced aircraft which will need a great deal of specialized equipment.

Conway Approval at 17,000 lb.

FULL airworthiness approval has been given to the Rolls-Royce Conway R.Co.10 by-pass turbojet. The Air Registration Board has granted a full British certificate of airworthiness for the engine at a thrust of 17,000 lb., the highest figure approved for any commercial engine in the West. Conways tested so far are an average of 140 lb. lighter than the guaranteed weight.

The Conway is to power the Boeing 707-420 and Vickers VC-10 aeroplanes on order by B.O.A.C. Conways are also specified by Lufthansa, Varig and Air India for the Boeing 707, and by Alitalia and Trans-Canada Airlines for the Douglas DC-8. Conway-powered airliners on order total 70.

Guaranteed minimum thrust for the R.Co.10. Mk. 505 by Rolls-Royce is 16,500 lb. The military R.Co.11 for the Handley Page Victor B.2 is rated at 17,250 lb., the civil R.Co.12 at 17,500 lb. and the R.Co.15 at 18,500 lb.

In view of the fact that the R.Co.10 and 12 civil ratings are only 1,000 lb. different, it would be logical to suppose that the higher rating will be attained with very small modification to the R.Co.10 engine after it has been in service for a time. Indeed, the type-test may well have been performed at a thrust somewhat higher than the approved figure.

News of Aircraft, Engines and Missiles

ROTOL SALE.—The Bristol Aeroplane Co., Ltd., and Rolls-Royce, Ltd., have agreed to sell to the Dowty Group, Ltd., their interests in Rotol, Ltd., which company will then become a wholly owned subsidiary of the Dowty Group, Ltd.

ORPHEUS-AIDED.—The 1,000-km. closed-circuit record set up by M. Bernard Wit in the Breguet Taon (Bristol Orpheus turbojet) on July 23 has been officially confirmed by the F.A.I. The speed achieved was 1,075.347 km.p.h.

VTOL PLANS.—In answer to a question in the House recently, the Minister of Supply said that, apart from work on helicopters, his Department was financing the S.C.1 research aircraft and other work, including that on engines, related to vertical take-off and landing systems. It was possible that "some arrangement might be reached with the Americans with a view to a joint project, but it is premature to comment on that at the moment."

MISSILE CANCELLATIONS.—The U.S.A.F. has abandoned development of the Goose long-range decoy missile, designed to confuse enemy defence systems, and the Rascal air-to-surface missile.

SUD SORT-OUT.—During a recent interview, M. Georges Hereil, president of Sud-Aviation, gave details of the development of the S.E. 116 family of aircraft. The S.E. 116 is the basic prototype and is at present powered by two 800-h.p. Wright Cyclone piston engines. The S.E. 117 Voltigeur is the military production version with two Bastan turboprops and is for tactical support. A civil derivative of the basic design is the S.E. 118 Diplomate 8-10-seat light transport. As 67% of the components of both the Voltigeur and the Diplomate are identical a common assembly line may be possible.

U.S. AIR SHOW.—Organized by the American Air Forces Association, a World Congress of Flight is to be held at Las Vegas in April. It will be the first international air show to be held in the U.S. and will cover military, commercial and private aircraft, missiles and accessories. The U.S.A.F. will be the host and all nations have been invited to participate, including the U.S.S.R. Many of the highlights of the 1958 S.B.A.C. Show may take part. The R.A.F. Hunters of No. 111 Sqn. are to be invited.

IRBM FUTURE.—U.S. Defense Dept. officials have said that no more Thor or Jupiter IRBMs are likely to be ordered after present production contracts are completed in 18 to 24 months' time. The reasons given were the trend towards solid-fuel rather than liquid-fuel rockets and the reluctance of certain NATO countries to grant bases for the missiles.

BOMARC CONTRACT.—The Boeing Airplane Co. and Canadair, Ltd., have signed a contract for engineering services in connection with the U.S. Bomarc SAM programme. Under this contract Canadair will send 150 engineers and technicians to Boeing plants in the U.S. for a minimum period of six months.

SNOOPER.—Republic Aviation Corpn. is developing the Swallow, a small jet-powered reconnaissance drone with a delta wing. It will be rocket-launched and recovered by parachute, and is for the U.S. Army Signal Corps.

SPEEDY DELIVERY.—The Convair Lobber solid-fuel cargo-carrying missile has successfully carried a 50-lb. payload six miles and attained 1,500 m.p.h.

NATO PATROL BOMBER.—Breguet is reported by *Aviation Daily* to have won the hotly contested competition for a new NATO patrol bomber. The Breguet design was evolved in association with Avro, Dornier, Fokker and Sud-Aviation and is powered by two Rolls-Royce Tynes. France, Germany, the Netherlands and Norway are thought likely to place orders. Other companies submitting designs are said to have included Bristol, Fairey, Vickers, Canadair, Lockheed and Douglas.

DART OVERHAULS.—Rolls-Royce Dart Mk. 510 turboprops in service with B.E.A. Viscounts now have an approved overhaul period of 2,000 hr. and trials are being made to extend the period to 2,100 hr. The Dart Mk. 506 has a 2,200-hr. period and trials are under way for 2,300 hr. The Dart Mk. 520 has a 1,000-hr. period which will be extended to 1,200 hr. after trials are completed.

Commercial Aviation Affairs

ROYAL GUEST.—H.R.H. the Duke of Edinburgh was amongst the many distinguished guests at the annual cocktail party given on December 17 by the British Air Line Pilots' Association at Londonderry House.

COMETS TO CANADA.—The first B.O.A.C. Comet service to Canada was due to leave London Airport for Montreal at noon on December 19, with Captain R. E. Millichap, manager of the Comet flight, in command. The return flight on this weekly service will leave Montreal at 20.30 hrs. local time each Saturday, arriving at London Airport at 08.15 G.M.T. on Sunday.

HUNTING-CLAN HAND-OVER.—At London Airport on December 11, Mr. Peter Masefield handed over a Britannia 317 to Sir Nicholas Cayzer, chairman of the British and Commonwealth Shipping Co., Ltd. This is the second of two Britannias for British and Commonwealth, the company which controls Union Castle and Clan shipping lines as well as holding a half interest in Hunting-Clan Air Holdings. The Britannias are to be registered in the name of Clanair, Ltd., a wholly owned subsidiary of British and Commonwealth, although it is probable that they will be leased for operation to Hunting-Clan Air Transport whose crews have flight-tested both aircraft.

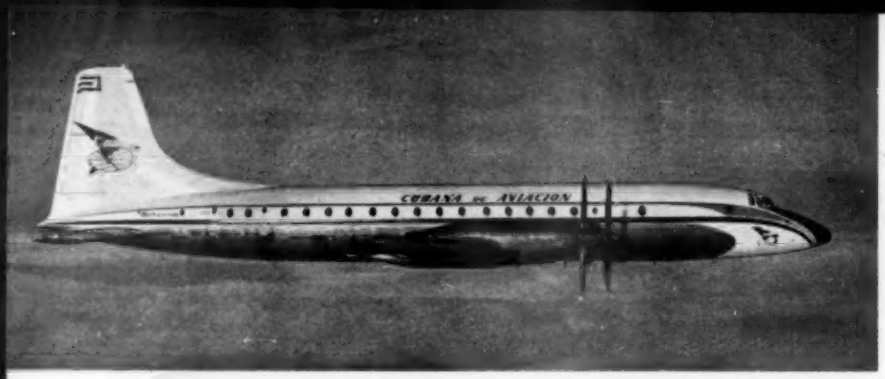
ETHIOPIAN MEMBERSHIP.—Ethiopian Airlines, Inc., will become an active member of IATA on January 1, making total membership 87 airlines of which eight are associate members.

PRAGUE PROGRESS.—Last month the Czech airline C.S.A. celebrated the 35th anniversary of the first flight by Aerolinia on the Prague-Bratislava route. In 1923, 29 passengers travelled by air in Czechoslovakia; now C.S.A. carries more than 1,000 passengers daily. Plans have been made to extend the main runway at Prague airport from 3,300 ft. to 9,000 ft. and to lay a new 11,500-ft. runway to cope with the expected introduction of jet aircraft on a large scale.

CAR FERRY TO BELFAST.—All new Vauxhall cars sold in Northern Ireland are to be delivered from Luton by air. Starting on December 16, B.K.S. Air Transport have been operating a daily service (week-ends excepted) with a Bristol 170 which carries either three Victors, or two Velox or Cresta cars with one Victor, plus about 4,000 lb. of spares and literature and one passenger. Contract cargo is being carried on the return flight from Belfast to Southend.

SEPTEMBER TRAFFIC.—Air transport movements at U.K. airports in September, 1958, increased by 3.3% over the September, 1957, level and the number of passengers handled increased by 2.3%. Freight was up by 23%. Movements at London Airport decreased by 4.5% as a result of the opening of Gatwick. Biggest increase of the month, by 58%, was at Southend.

AEROFLOT TO EGYPT.—On December 5 Aeroflot inaugurated a Tu-104 service between Moscow and Cairo.



CUBAN TURBOPROP.—The first of four Britannia 318s for Cubana de Aviacion left Filton for Havana on December 16, crewed by Cubana personnel under Capt. "Bill" Cook, chief pilot. Cubana expects to put Britannias into service on the routes from Havana to Mexico City and New York early next year and later across the Atlantic via the Azores to Madrid.

FRIENDSHIP IN SERVICE.—The first commercial passenger flights by the Fokker Friendship in Europe were operated by Aer Lingus on December 15 from Dublin to Glasgow and Liverpool. The Friendship went into service on the Dublin-Paris route on December 17.

RUNWAY AT LUTON. — Luton Corporation is proceeding with a £300,000 plan to build a mile-long runway at Luton Airport, which at present has only grass runways. Construction is expected to start next March and will take eighteen months to complete.

BOEING SPARES SERVICE.—A new Boeing spares store for the 707 and 720 is to be opened at New York International Airport in mid-January. Over 3,500 separate items will be stocked, and a direct teletype service between the store and Renton will be maintained.

News About People

MASTER PILOTS.—GAPAN has awarded Master Air Pilot certificates to the following Captains: J. W. Benton and B. K. Fuller, check captains on T.A.A. Viscounts; G. E. Colley, D.F.C., B.E.A. captain 1st class; D. F. Redrup, D.F.C., B.O.A.C. senior captain, DC-7C fleet; J. R. C. Young, B.O.A.C. senior captain Argonaut fleet.

WELL DESERVED.—Col. John Paul Stapp, of rocket-sled fame, was recently elected president of the American Rocket Society.

FINNS AT FOLLANDS. — Mr. Katajarinne, Secretary of State to the Finnish Ministry of Defence, accompanied by Maj. Kettinan, assistant air attaché, visited Folland Aircraft, Ltd., on December 12. They were met at Eastleigh, Southampton, by Mr. E. W. Taylor, the company's works manager, and saw Gnat major assemblies. At Hamble they saw the final assembly line of Gnats, and then lunched with Mr. W. E. W. Petter, managing director and chief engineer of the company, and other officials. A visit was later made to the flight development unit at Chilbolton, although bad weather prevented flying. Finland has 12 Gnat Mk. 1s on order; two have been delivered.

AN ENGINEER RETIRES.—After being closely connected with American naval aviation development for 36 years, Mr. Caryle S. Fliedner retired last month. He was technical assistant to the director of the Power Plant Division of the Bureau of Aeronautics. Throughout his service he has been concerned with research, developmeat and the Service operation of naval aircraft powerplants.

AER LINGUS APPOINTMENTS.—Continuing the integration of the managements of Aer Lingus and Aerlinte, further changes have been announced. Mr. J. T. O'Briain is now commercial planning manager and Mr. A. Donohoe becomes chief accountant to the two companies. Capt. S. Williamson is appointed operations manager and chief pilot; Capt. A. Quigley becomes assistant chief pilot and Capt. G. Wade chief instructor.

ELLIOTT APPOINTMENT. — Mr. W. A. Fraser has been appointed manager of the newly formed inertial-navigation division of Elliott Brothers (London), Ltd. In conjunction with the M.o.S. and the R.A.E. Elliotts have developed the inertial-navigation system for the Avro stand-off bomb.

LIAISON CHIEF.—Mr. J. R. MacKenzie has been appointed head of the office of legislative liaison of the U.S. Federal Aviation Agency. He will advise and assist Mr. E. R. Quesada, administrator of the Agency, on matters involving relations with members of Congress.

I.T.A. OFFICERS.—Officers of the Institut du Transport Aérien have been elected as follows: president, M. A. Siegfried; vice-presidents, M. W. Deswarte (Sabena) and M. P. Moroni (S.G.A.C.C.); assessor, M. L. de Azcarraga (Spanish Air Ministry); treasurer, M. H. Bouche (the founder of I.T.A.); and board members, Senator G. Caron (Italy), Dr. Slotemaker (K.L.M.), and Générale Fayet (S.N.T.A.).

Military Aviation Affairs

LUFTWAFFE EXPANSION. — The Federal German Air Force recently put into service its fourth wing of F-84F Thunderstreak fighter-bombers, bringing the total current establishment to nine squadrons, each with 25 aircraft. These are due to be placed under NATO command early in 1959, and 450 Thunderstreaks will be in Luftwaffe service by 1962. So far the Luftwaffe has 1,500 aircraft of all types including some in storage, trainers, and 50 transports in a Wing of two squadrons.

GERMAN HELICOPTERS. — The Federal German Defence Ministry is placing further orders for a substantial number of helicopters for its armed forces, from France and the U.S. The French order, which is worth about £3 million, is for 120 Sud-Aviation Alouette shaft-turbine helicopters, which will be built partly under licence by Heinkel. From America will come 25 rotorcraft of unspecified types.

INDONESIAN GANNETS...—It was stated in Parliament last week that export licences for six Fairey Gannets had been granted for the Indonesian Air Force, and that possibly 12 more would follow. Indonesian airmen have already been training with the R.A.F., although their air force has been supplied with a number of Russian jet fighters and bombers.

... AND CUBAN FURIES.—Another Parliamentary reply revealed that 17 military aircraft, presumably all Hawker Sea Furies, have been supplied to the Cuban Government, with a supply of rockets.

EGYPTIAN SORTIES.—Jet aircraft of the Egyptian Air Force, believed to be Ilyushin Il-28s, last week made several night sorties, apparently on reconnaissance, over Israel. Flares were dropped over Port Eilat and other points along the Israel-Jordan demarcation line.

SOVIET AIR POWER.—Latest NATO reports credit the Soviet Air Force with 20,000 aircraft plus 2,500 in satellite countries. Most are jet-powered. Soviet man-power strength is 800,000.

R.A.A.F. VISITS.—Last month four R.A.A.F. Canberras of No. 2 Sqn., based at Butterworth, Malaya, visited Thailand and Laos. Taking part in a flying display over Vientiane, Laos, the formation refuelled at Bangkok.

R.A.F. GRADUATION.—As recorded on page 918, the passing-out parade of 74th Entry of flight cadets took place on December 16, at the R.A.F. College, Cranwell. Left to right, S.U/O T. V. Spencer, the best all-round cadet, S.U/O D. G. Lucas, first in the final examinations, and U/O J. Delafield, the best pilot of the entry.

Air Transport

Significant Applications

THE decision which the Air Transport Advisory Council and the Minister of Transport must eventually reach on the cheap-fare colonial-coach applications by Eagle Aviation is likely to be one which will have quite profound implications.

Whatever the decision reached it will not be an easy one. As we briefly recorded in last week's issue (p. 881), Eagle have applied for permission to operate passenger and freight services to 11 colonial destinations at fares (ranging from about 3.5 to 2.5 pence per st. mile) which are about half the existing tourist-class rates and which are lower, except in one case, than those for travel by sea.

Since the Minister of Transport offered a "new deal" to the independents in 1952 by providing opportunities for cheap-fare operations on colonial routes it has been made clear that the qualifications for competitive services were difficult to apply and, in some cases, illogical. Apart from the obvious qualification that such services must not "in any way" impair the competitive strength of our international air services" the others were that a lower class of service, in terms of aircraft type, shorter stage-lengths, passenger amenities and baggage allowances should be offered and that the fares charged and frequencies planned should be such as to "ensure dependence on the new class of traffic."

In the early days such vaguely defined limitations could be met fairly easily—but not today. Eagle is applying for permission to operate the services with long-haul aircraft—DC-6As at the start, and, later, Britannias or, possibly, Comet 4s. Obviously it would be ridiculous for the A.T.A.C. and the Minister to insist, today, that such aircraft cannot be used, or that, if used, they should fly over uneconomic stage-lengths on routes where there could be no intermediate traffic rights.

Nevertheless, these requirements could be used as a reason for refusing the applications unless the wording of the terms of reference is altered. The Eagle fares are so extremely low and the initial frequencies such that the services must necessarily be considered as ensuring a "dependence on the new class of traffic"—but other operators will undoubtedly claim that some of their prospective passengers are being diverted. Some of those who must travel, and who are paying the fare out of their own pockets, will obviously choose to travel rough and to save money—but that is the natural way of things. In fact, the fares proposed by Eagle are comparable with those charged on Australian services and on U.S. tourist-class and coach-class services.

For the rest, Eagle's plans involve the use of a seat-pitch of 33½ in. and of a free baggage allowance of 33 lb. (by comparison with 44 lb. on tourist services). Food, drink and, thus, cabin service, will be paid for by the passenger and, to save possible difficulties, Eagle is prepared to restrict the passengers travelling on the services to those holding a British passport and to members of Her Majesty's Forces.

The destinations, return fares and frequencies of the proposed services to and from London are as follows:

Fortnightly: Aden (£107) and Singapore (£199); Nassau, Bahamas (£140) and Kingston, Jamaica (£150); Trinidad (£165); Kano (£82) and Lagos, Nigeria (£93); Nairobi (£101). Weekly: Cyprus (£41 15s.) and Malta (£19). Monthly: Gibraltar (£21 4s.)

Aircraft Exchange in London

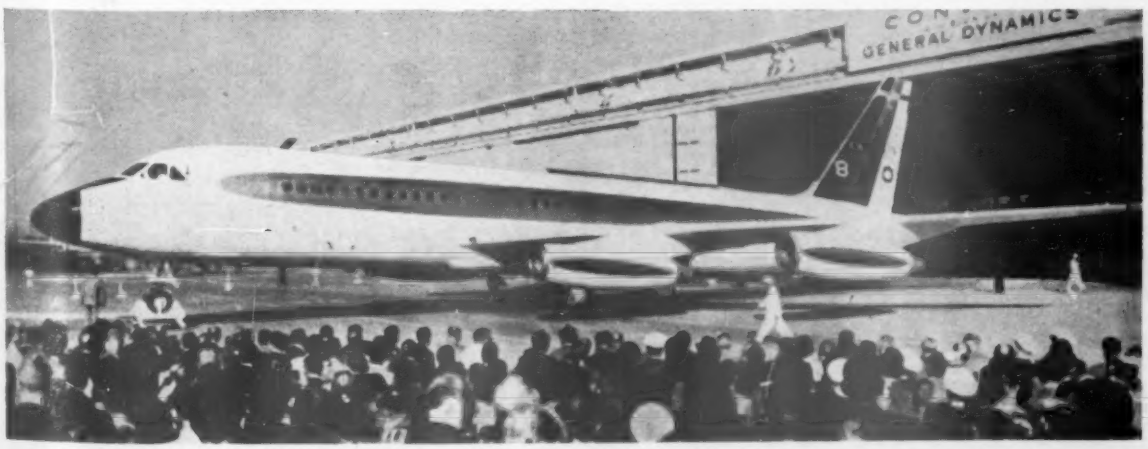
MORE can now be said about the aims and activities of Aircraft Exchange, Inc., which is to begin operations in New York on January 6 and in London later next month. Details were given to us last week by the vice-president of the organization, Mr. Charles N. Biondi, after we had gone to press with the note on page 884 of our previous issue.

Foundation of the exchange at the present time has been influenced by several factors, said Mr. Biondi. These include the swing from a sellers' market to a buyers' market in second-hand aircraft; and the increasing use of trade-in arrangements, as a result of which aircraft manufacturers will themselves be seeking an outlet for older types of aircraft. By establishing what should eventually be a World-wide market-place, Aircraft Exchange hope not only to increase the sales of second-hand aircraft, but also help to stabilize their prices. At the present time, valuations of used aircraft vary enormously—Mr. Biondi quoted one example where two parties valued the same aircraft at $400,000 and $1,200,000 respectively. Stability in prices should help to bring bankers and finance houses into aviation deals more readily.

The activities of Aircraft Exchange—which is a co-operative, limited profit organization—will be strictly restricted to receiving and matching bids and offers, and preparing the weekly market report. To advise on the running of the service and ways in which it might be modified or improved, a policy council is to be set up, representing all classes of membership—regular, associate and service. An affiliated, independent company, Aircraft Exchange Service Corp., is also to be established to help users of the exchange, if they so desire, to find means of financing and to arrange insurance, modifications, ferrying and so on.

To begin with, the London operations will be undertaken as a branch of the New York corporation, but an entirely British company will probably be formed in due course. The London office will be the European headquarters of the organization, and a similar headquarters may be established eventually in Latin America. The activities in London and New York will be closely integrated, and the weekly market report will be common to both and cover all bids and offers made during the week. Initially the report will be issued only from New York; a simultaneous London edition is planned later.

A "well-known figure in the British aviation industry" is to be appointed in charge of the London office, and representatives of the U.K. aircraft industry will be invited to join the policy council. Until a permanent office is established here the London address is 47 Princes Gate, S.W.7; the New York office is at 522 Fifth Avenue, New York 36, N.Y.



ROLL-OUT.—The first Convair 880 was rolled out of the final assembly building at San Diego on December 15 and is expected to begin its flight trials at the end of January. Orders for the 880 and the larger derivative, the 600, now total 87, and the type is expected to be in service early in 1960.

Discussing Turbine Problems

AT intervals of about three-four months, representatives of the European airlines have, during the past two years, been holding conferences on turbine overhaul problems. The eighth in the series was held last week in London with British European Airways as hosts; the previous conference was held in September in Hamburg.

The programme which is followed usually involves the answering of a series of pre-set and other questions on current problems by different operators' representatives, the presentation of papers, discussions and visits to factories or overhaul organizations. The subjects of the questions range over such widely varying matters as the "scrambling" of engine components before re-assembly, the use of incentive schemes and experiences of welding Nimonic alloys.

During this month's conference visits were paid to the B.E.A. Engineering Base and the Rolls-Royce factory and papers were given on synthetic oil reclamation (B.P.), turbine-engine fuel storage (Esso), Avon and Conway engines (Rolls-Royce) and equipment handled by American Avitron. Some 35 delegates from 13 airlines and 25 representatives of engine and other companies attended the four-day conference.

See How They Grow

INCREASES in the maximum take-off weights of various types of transport aircraft are announced from time to time and accepted as a matter of course. Some weight growth is to be expected in the course of bringing a new type from project design to first flight. Thereafter, improvements in engine performance and practical experience with the type frequently make possible comparatively small increments in maximum permissible gross weight.

Much greater weight increases are associated with physical "stretching" of the fuselage and/or wing. Stretching of this kind is usually associated with the provision of more fuel and more passenger accommodation.

The table which follows, whilst not being completely exhaustive, indicates the order of growth of the various current transport types to date. The "starting weights" are those applicable to the design at the time it passed from project to detail design stage for the British types, and the earliest announced weights for U.S. types. Maximum weights quoted are those applicable to the largest and heaviest version of the same aeroplane so far announced.

We have also shown, in parentheses under this heading, the present weights of the original version of the design—i.e. with no physical stretch involved. The list is arranged in order of starting weight dates, and percentage increases are shown.

	Starting wt. (lb.)	Present wt.* (lb.)	Increase (%)	Elapsed years
Comet (1 to 4)	93,000 (1946)	158,000 (117,000)	70	12½
Boeing 707 (120 to 420)	200,000 (1949)	312,000 (247,000)	60	10
Viscount (700 to 810)	48,000 (1949)	72,500 (64,500)	51	10
Britannia (100 to 310)	130,000 (1951)	180,000 (155,000)	38.5	8
Douglas DC-8	211,000 (1954)	310,000	47	5
Vanguard	110,000 (1955)	141,000	28	3½
Electra	98,500 (1955)	116,000	17.5	3½
Caravelle	90,000 (1955)	99,000	10	3½
Convair 880 (to 600)	172,500 (1956)	238,200 (203,400)	38	2½

Note: * Including, in parentheses, the present maximum weight of the original "unstretched" version.

The difficulty of obtaining appropriate "starting weights" for the various aircraft at directly comparable stages in their development makes it necessary to treat this comparison cautiously. It is clear, however, that the weight growth rate follows a broad pattern in which the average increase can eventually be expected to come out somewhere between 6% and 8% per year. The Convair 880 is a major exception, with a 38% increase recorded in two and a half years; this rate of increase is likely to be less, however, as time goes on.

Turboprop Operations in Theory

By way of postscript to our recent summary of a valuable paper on long-haul operations with the Britannia, here, for the benefit of airline technicians, are further extracts explaining the theories from which some basic operating parameters are derived.

GETTING the most out of a modern transport aeroplane, particularly when operating over the longer ranges and the more difficult routes, calls for a clear understanding of the parameters which influence the aircraft's performance. Although the application of the theory may prove, in practice, to be comparatively simple, the theory itself is not always so easily understood and for this reason alone, it may well be, different operators of the same equipment over the same routes may achieve different degrees of commercial success.

All this was made abundantly clear by Mr. J. E. D. Williams in his paper on "The Operation of the Britannia 300" given before the Bristol Branch of the R.Ae.S. earlier this month. When we summarized this most interesting paper in THE AEROPLANE for December 12 we excluded those portions dealing with theory, as they required a rather more detailed treatment. This now follows, with the relevant extracts given here, for the most part, verbatim.

Mr. Williams was discussing the long-range Britannia specifically. A theoretical examination of the operating methods required in the case of other aircraft types would be made along the same lines, although the precise form of equations might differ in certain respects. As previously noted, the author was particularly concerned with three cruise control procedures: optimum economy, maximum range and optimum range; he also discussed the importance of payload planning and its influence on economic operation.

Theory of Optimum Economy Cruise

For a company of known cost characteristics, the cost of operating a Britannia on a particular flight may be assumed to be of the form:—

$$\text{Trip cost} = AT + BF + C + \int_0^T \phi(p)\,dt. \qquad (1)$$

where A = hourly cost ($/hr.)
B = fuel cost ($/lb.)
F = fuel consumed (lb.)
C = fixed trip cost ($)
$\phi(p)$ = engine cost ($/hr.)
T = trip time (hr.).

(The "hourly cost" comprises those cost items which are truly variable with time and is not necessarily related to the "hourly direct operating costs" as the phrase is used in cost formulas.)

The engine cost is assumed in this equation to be a function

(*Continued on page 925*)

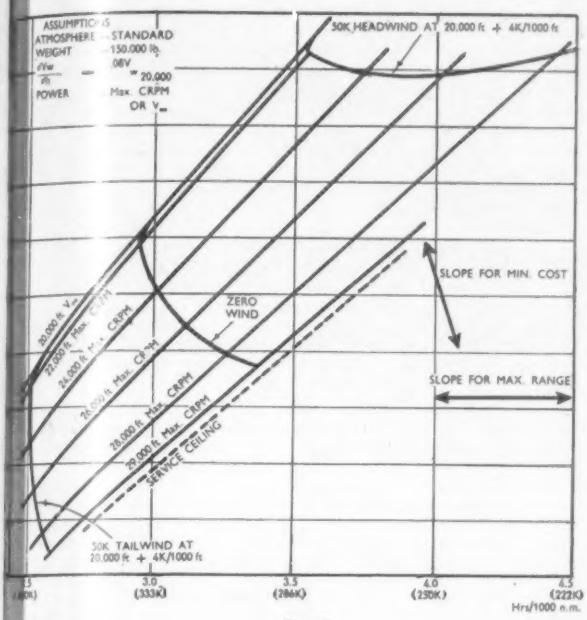


Fig. 1.

(*Continued from page 924*)

of some engine operating parameter, p. On some piston engines a marked correlation has been observed between cruising power and maintenance and overhaul costs. In one case, a marked saving both in premature engine changes and in overhaul material costs was observed by reducing cruise power by an average of 75 b.h.p. Comparable effects are difficult to observe on the Proteus 755/781. Premature engine withdrawals are not frequent and there is no known correlation between premature withdrawals and cruise technique within the currently permitted limits (correct engine handling assumed). In consequence, ø (p) must be considered a constant and may be added to A to give A^1.

Hence the general expression for trip cost gives:—

$$\text{Trip cost} = C + \int_0^S \frac{A^1 + Bf}{V_A + V_W} ds \qquad (2)$$

where S = stage length (n.m.)
f = fuel flow (lb./hr.)
V_A = T.A.S. (knots)
Vw = wind component (knots).

The derivation of the minimum value for this integral in the wind and temperature field of a particular flight is out of the question for manual computation, but would be perfectly practical for a suitable digital computer, integrating backwards from required landing weight in small segments. The problem is simplified by the limited number of flight levels, which give a limit to the inputs required on performance, wind and temperature. It is believed that this method of operational planning is not currently in use.

Practical Procedures for Optimum Economy

These can be simply demonstrated by making the approximation that maximum trip economy is achieved by operating at instantaneous maximum economy.

Consider flight at a fixed level so that fuel flow may be considered a function of speed at a specified weight and air temperature. Then, from equation 2:—

$$\text{Cost per nautical mile} = \frac{A^1}{V_G} + \frac{B}{\beta}$$

where V_G = ground speed
β = n.m. per lb./fuel (including wind effect)
= specific range × $\frac{V_G}{V_A}$

Hence minimum cost per n.m. occurs when

$$\frac{A^1}{B} + \frac{d(1/\beta)}{d(1/V_G)} = 0 \qquad (3)$$

At any fixed altitude within the normal operating belt, it is found that $\frac{A^1}{B} + \frac{d(1/\beta)}{d(1/V_G)} > 0$, provided drag rise does not occur.

Quite simply, as one increases power up to VNO or max. c.r.p.m., whichever is limiting, the saving on hourly costs is normally greater than the additional cost of fuel unless drag rise occurs first.

Hence, for all practical purposes on the Britannia 300 with 755 engines, the optimum economy cruise at any given altitude is at VNO or max. c.r.p.m., whichever is limiting.

Consider flight at maximum permissible speed (whether limited by c.r.p.m. or VNO) at a specified weight and air temperature. Then with the new variables the optimum altitude is that which satisfies equation 3. The value of $\frac{A}{B}$ is of the order of 15,000 lb./hr. depending on what one pays for Britannias, paraffin and a few other things.

Fig. 1 is a grid on which altitude and wind component lines are plotted with axes inverse specific range and inverse speed. The assumed conditions in this example are I.S.A., weight 150,000 lb., Proteus 765 engines, and a vertical wind shear, $\frac{d\,V_W}{d\,h} = .08 \times V_{W30,000}$ (the wind component at 20,000 ft.). The wind component lines are plotted for zero component, 50-knot headwind and 50-knot tailwind at 20,000 ft. A 50-knot wind at 20,000 ft. increasing to 90 knots at 30,000 ft. is typical of a strong westerly wind belt in temperate latitudes. Below 21,900 ft. (the VNO altitude), c.r.p.m. is reduced in order not to exceed VNO. It is clear that:—

1. In light winds, minimum cost altitude is 0-2,000 ft. above the VNO altitude.
2. In light or tailwinds, maximum range is near service ceiling.
3. With large tailwind shears, minimum cost altitude is about 6,000 ft. above the VNO altitude.
4. In strong headwind shears minimum cost is as near to VNO as possible.
5. Maximum range in the strong headwind case shown is about 5,000 ft. lower than in still air. Furthermore, unless absolute maximum range is required, very large improvements in ground speed are obtained for quite a trivial sacrifice of range by flying slightly above the VNO altitude.
6. There is no case (within the range of wind speed shown) in which either economy or range can be improved by flying below the VNO altitude. Speed can only be improved by flying below the VNO altitude if headwind shear exceeds 4.5 knots.

Since vertical separation of traffic in any case limits aircraft to flight levels at 2,000 ft. intervals it is obviously possible to formulate quite simple rules for altitude selection for minimum cost cruise. The best practical procedures to specify for a particular operation depend on the cost structure of the company, the competitive importance of speed, and not least on the practical realities of weather and Air Traffic Control on the route.

Maximum Range Cruise

The condition of maximum specific range in the Britannia (with Proteus 755 engines) is obtained at max. cont. compressor r.p.m. at the altitude where this setting gives a speed of 1.4 VIMP (1.06 VIMD). This calls for a drift up at about 1,000 ft./hour as VIMP decreases with decreasing weight.

In most A.T.C. situations, the stepped climb in 2,000 ft. steps is the nearest permissible approach to the "drift-up." In still air or with a tailwind this is a straightforward technique in which I.A.S. is the determining parameter for the start of each climb. In headwinds, the situation is different.

Maximum Range in Headwinds

Headwinds normally increase and true airspeed decreases with altitude in the range of Britannia operating altitudes. It follows that the altitude of maximum range in headwinds is usually a lot lower than in still air. The point is demonstrated in Fig. 1. Cases occur on the North Atlantic where by flying 8,000 ft. below the altitude of maximum specific range one gains 22% on range and 61% on ground speed. The altitude of maximum range is given by:—

$$\frac{1}{\alpha}\frac{d\alpha}{dh} = \frac{V_W}{V_A + V_W}\left(\frac{1}{V_A}\frac{dV_A}{dh} - \frac{1}{V_W}\frac{dV_W}{dh}\right) \qquad (4)$$

where α is specific range.

The difficulty is that there is no means in practice of measuring wind shear. An analysis conducted for El Al by Mr. C. S. Durst, agreed closely with the El Al opinion that in the special case of the London-New York leg, best results could be obtained by assuming that headwind shear is a function of headwind. This simplifies the flight planning/navigation problem enormously by eliminating one variable. In the El Al technique, wind component lines superimposed on the flight planning/howgozit chart give direct presentation to the

navigator of when to climb in terms of headwind, aircraft weight and ambient temperature.

Equation of the Optimum Flight Profile

Flight for optimum range is probably the most important case for the Britannia, being basic to North Atlantic operations and also used by C.P.A. and Aeronaves. The equation of the optimum flight profile is a complex one, arrived at as follows:—

At a point P_1 on the optimum flight profile let the aircraft be displaced slightly from the profile for a distance S. Then for sufficiently small S, $\delta T = -S\delta V_G/V_G^2$ and $\delta F = -S\delta\beta/\beta^2$

where T=flight time, and F=flight fuel.

Hence $\left(\frac{\partial T}{\partial F}\right)_W \left(\frac{d\beta}{dV_G}\right)_W = \frac{\beta^2}{V_G^2}$

where W=aircraft weight. For a defined profile $(\partial T/\partial F)W$ may be written $\phi(W)$. Let a small displacement for a short period at weight W_1 produce a fuel increment $(\delta F)_1$, $(\delta F)_1 > 0$. Then $(\delta T)_1 = (\delta F)_1 \phi(W_1)$. Let the path be displaced at any point W_2 to produce a fuel increment $(\delta F)_2$ where $(\delta F)_1 + (\delta F)_2 = 0$.

Then $\delta T = (\delta T)_1 + (\delta T)_2 = [\phi(W_1) - \phi(W_2)](\delta F)$.

By definition of the optimum profile, since $\delta F = 0$, $\delta T \geqslant 0$ so that $\phi(W_1) - \phi(W_2) \geqslant 0$ for all W_1 and W_2, which implies $\phi(W_1) - \phi(W_2) = 0$ for all W_1 and W_2.

Therefore, for any optimum flight profile,

$$\left(\frac{\partial T}{\partial F}\right)_W = \text{constant}$$

$$\left(\frac{V_G}{\beta}\right)^2 \left(\frac{d\beta}{dV_G}\right)_W = \text{constant}$$

$$\left(\frac{d(1/\beta)}{d(1/V_G)}\right)_W = \text{constant} \qquad (5)$$

which is the general equation of the optimum flight profile, provided it exists and is continuous. There is no existence theorem; in fact, Fig. 1 shows that all values of the constant cannot be satisfied because of the limitations of aircraft performance. Even constant=zero cannot be satisfied with sufficiently strong tailwinds, in which case, maximum practical range is attained by flying at ceiling. It can, however, be shown that for all T between the time on the least practical time profile and the time on the maximum practical range profile there exists an optimum flight profile.

The equation can be solved, for the conditions of an individual flight, with a digital computer or graphically. The graphical solution, however, is too laborious for manual flight planning on scheduled operations. Furthermore, one planned optimum flight profile does not meet the operational requirement, since, as a flight progresses, the uncertainty as to future requirement for fuel decreases.

Fortunately for aircrew and flight planners, this problem is simplified by the fact that, with normal vertical separation between traffic, an optimum flight profile, modified by varying fuel reserve requirements, rarely involves more than three flight levels. Hence, the whole problem usually reduces to determining the time at which to commence one or two step climbs.

The most fertile practical procedure with a howgozit/flight planning chart, such as that used by El Al on the westbound North Atlantic leg, is to treat extra fuel available for burning as mathematically equivalent to an extra headwind for the purpose of determining how long to delay a step climb. Good practical procedures are empiricisms of the route, and can, on some routes, be remarkably simple without sacrificing significant economic advantage.

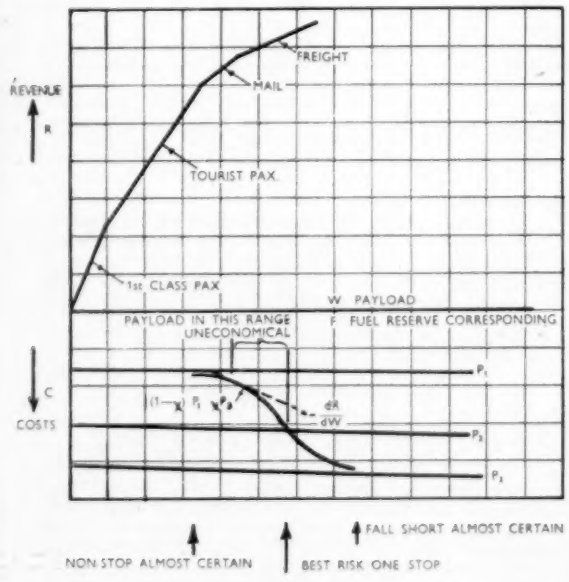


Fig. 2.

Payload Planning

Of the various other factors influencing successful commercial operation, that described as payload planning calls for a nicety of judgment. This involves, in the case of the Britannia, not only a measure of control to make the best use of the space available on all segments and not merely on the peak load segment, but two other problems—which will not be unknown to operators of other types of aircraft.

Before commencing Britannia operation, the management of El Al decided to operate a non-stop service London-New York on x% of occasions. In order to do so, payload booking was conservatively limited to y kilos, which paper operation predicted could be carried non-stop on x% of occasions. This was a conservative policy because on some occasions y kilos were not fully sold so that unpredicted non-stop flights took place when adverse conditions coincided with light loads. In consequence x was slightly exceeded and when commercial experience in selling Britannia payload was gained it became possible to increase the limit in small stages. The amount by which the limit exceeds y kilos depends on the frequency on which the flight is undersold, and should vary seasonally.

Another problem occurs during flight planning for all operators working near the maximum range condition. Last-minute freight is offered and its carriage increases the risk of a technical stop. A decision has to be made.

The analysis is as follows:—

Let R = Revenue from payload W.
P_1 = the cost of a non-stop.
P_2 = the cost of a planned one-stop.
P_3 = the cost of a fall-short, i.e., of an unplanned landing for refuelling.

P_2, P_3 may include the estimated value of adverse passenger reaction and any bias to be given to a managerial decision to maintain a high frequency of non-stop service.

Let χ = the risk of falling short with a given fuel reserve in given conditions.
W = payload.
F = planned reserve fuel permissible with payload W.

Then revenue against load may be plotted as shown in Fig. 2, the slope of the curve decreasing with the lower revenue per pound class of payload.

On the inverted axis the costs P_1, P_2, P_3 may be plotted against the fuel reserve permissible (corresponding to the payload scale). The curve $(1-\chi)P_1 + \chi P_3$, representing the statistical cost of an attempted non-stop, may be plotted as shown.

Then, for all W at which $(1-\chi)P_1 + \chi P_3 > P_2$ a planned one-stop is better than a try at a non-stop.

All W at which $(P_3 - P_1)\frac{d\chi}{dW} > \frac{dR}{dW}$ is uneconomic load to carry on a non-stop.

The various cases are represented graphically in Fig. 2, but this is hardly the thing to present to duty dispatchers. They can, however, work with a table something like this:—

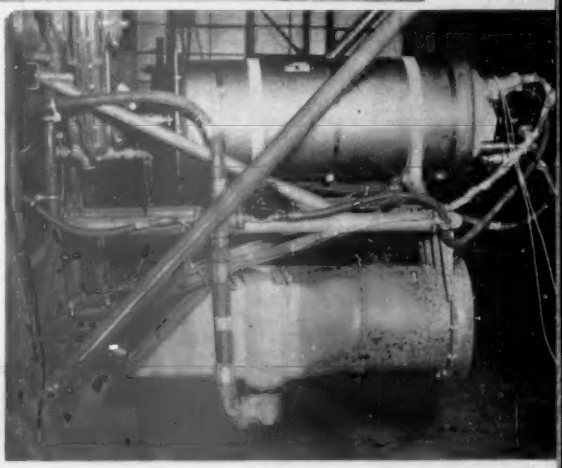
Commodity Rate, $ per kilo.	Accept load to point where permissible fuel load exceeds max. range flight plan with appropriate terminal reserves
—.—	————————
—.—	————————
—.—	————————
—.—	————————

which is simply a translation of equation 5, after assigning the values P_1, P_2, P_3, χ which are appropriate to the operations. It will be seen that the decision whether to carry or not is determined by a terminal reserve requirement variable with conditions in the destination area as well as route requirements. The method (rightly) assumes that it is always more economical to go on a longer range cruise than leave any commodity behind.

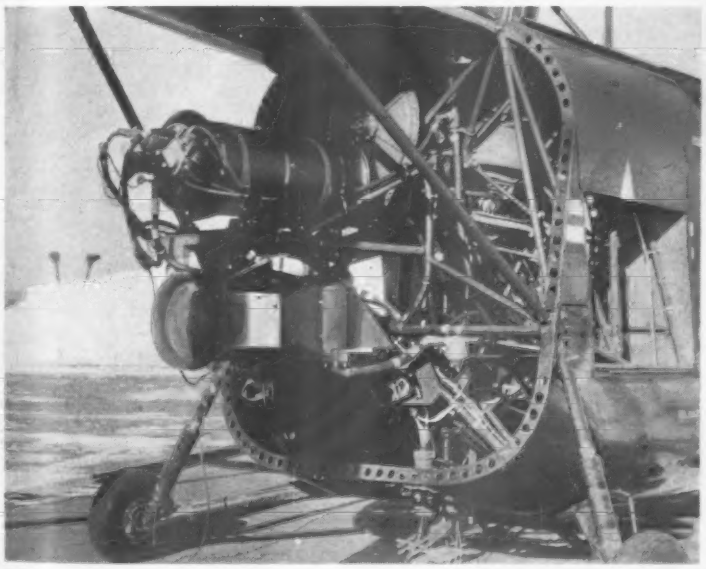
Kaman's Electric Helicopter

A test programme with the Kaman Aircraft Corporation's electric-powered robot helicopter, carried out under a Bureau of Aeronautics contract, has now been completed. The craft was a Kaman HTK-1 two-seater, whose 240-b.h.p. Lycoming piston engine was replaced by a Task Corporation electric motor of equivalent h.p. The accompanying photographs are the first detail views to be cleared for publication.

Howard Levy photographs



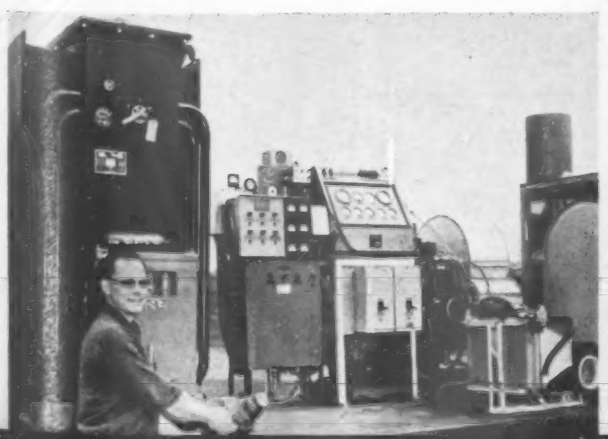
Above, a close-up of the electric powerplant in the helicopter.

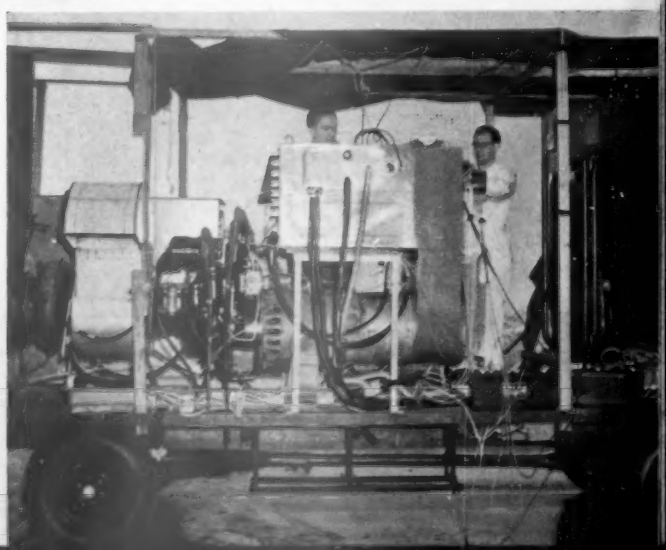


Left, the Task oil- and air-cooled induction motor, which replaced the standard Lycoming piston engine in the Kaman HTK, drives the rotor system through an auxiliary spur gearbox. Below the motor is an oil cooler for test purposes.

Below, ground electrical equipment consists of a 250-kW AC generator driven by a Solar gas turbine, and a high-voltage step-up transformer (shown at the right of the trailer) giving 2,200 volts at 400 cycles.

Below, another view of the power trailer showing the control panel. The Kaman technician is holding the cable plug which connects with the underside of the helicopter.





Blackburn's Free-turbine A.129

THREE British aero-engine manufacturers are planning to build shaft-turbine engines in what can be loosely termed the 1,000-h.p. class. One of these is an American type to be built under licence in Britain, one is a totally new design, and the third, the Blackburn A.129, represents a very logical advance from an existing line of proven engines.

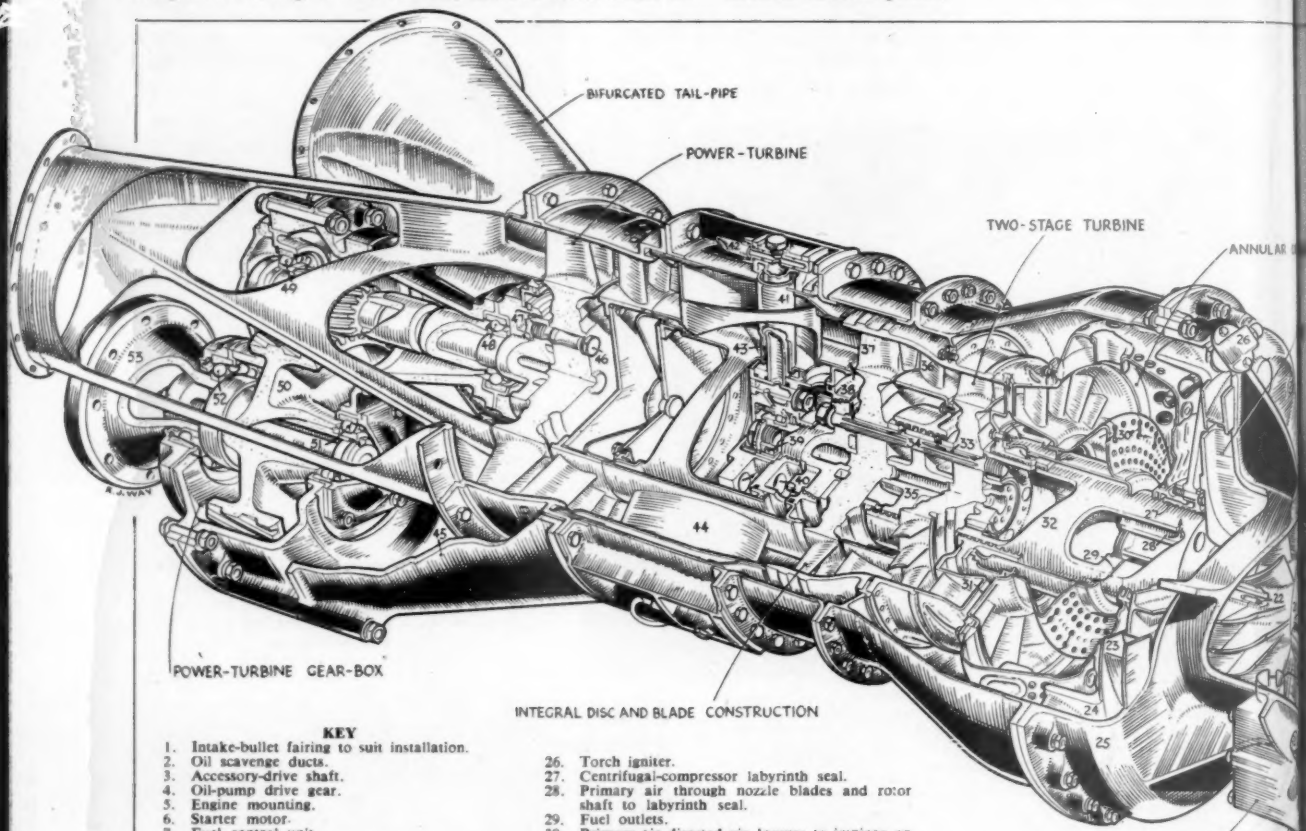
All three of these engines develop powers close to 1,000 h.p. and all three are being produced with a view to their initial use as helicopter powerplants. The A.129 is at present a lower-powered engine than its two rivals; in its first development stage it will produce 840 h.p., but a later version will give 970 h.p. The engine has considerable potential for development to give higher powers.

A free-turbine engine, the A.129 is in effect an Artouste 600 which has been supercharged by the addition of two axial-compressor stages at its forward end. Connected to the rear of this gas-generator unit are a free turbine and reduction gear which are based on those of the existing Turmo engine produced by Blackburn and General Aircraft, Ltd.

The A.129 has been designed from scratch as a simple and straightforward engine with no frills, and one which makes the greatest possible use of components from the existing range of Blackburn engines. This policy of development from existing engines and the use of common and proven parts will reduce greatly the mechanical development work necessary for the A.129, as well as keep its cost low. Nearly 70% of its parts, and their associated tooling, are used on earlier Blackburn engines.

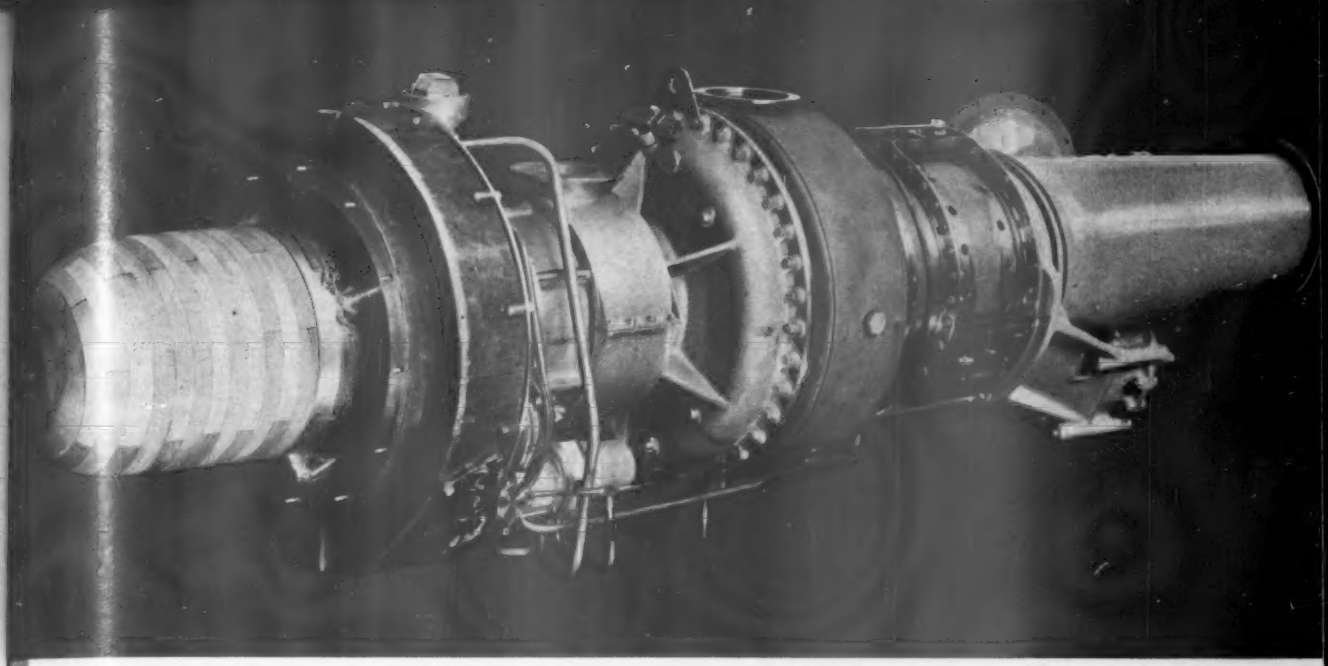
The low cost of the engine is regarded by Blackburns as one of its greatest selling points and, in fact, assuming a production run of some 200 engines, the unit price will be under £10,000. The first application of the A.129 will probably be a trial installation on the Saunders-Roe P.531 helicopter, early versions of which are powered by the Blackburn Turmo. The close relationship between the Turmo and the A.129 has enabled Blackburns to offer conversions of the former to the A.129 at a cost of under £5,000.

Rapid development of the new engine has been possible. Design work began early this year and the A.129's first test-bed run, in gas-generator form, was on July 31; as a complete free-turbine engine it first ran in August. By the end of November the engine had completed 25 hr. of test-bed running, most of which had been devoted to performance tests rather than to mechanical development.



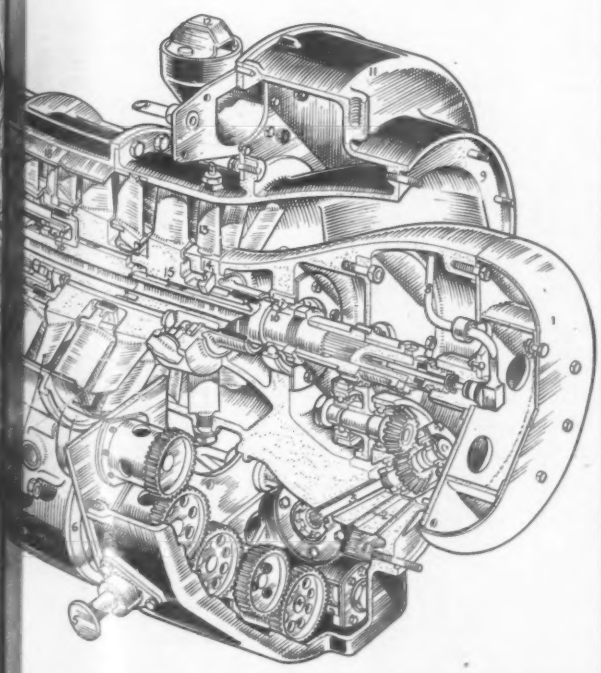
KEY

1. Intake-bullet fairing to suit installation.
2. Oil scavenge ducts.
3. Accessory-drive shaft.
4. Oil-pump drive gear.
5. Engine mounting.
6. Starter motor.
7. Fuel control unit.
8. Fuel inlet pipe to centrifugal diffuser.
9. Flange for intake duct.
10. Ball bearing at front of compressor.
11. Intake casing with oil reservoir in top half.
12. Oil filler and filter.
13. Master variable inlet guide-vane.
14. Actuating ring for variable inlet guide-vanes.
15. Second-stage air to front-bearing labyrinth seal.
16. Compressor roller bearing.
17. Two stages of outlet guide-vanes.
18. Slotted blade shrouds for stators and outlet guide-vanes.
19. Serrated coupling.
20. Flexibly mounted ball bearing.
21. Carbon blocks in labyrinth seals.
22. Locating dowels between centrifugal compressor and its guide-vanes.
23. Radial diffuser.
24. Axial diffuser.
25. Main casing.
26. Torch igniter.
27. Centrifugal-compressor labyrinth seal.
28. Primary air through nozzle blades and rotor shaft to labyrinth seal.
29. Fuel outlets.
30. Primary air directed via louvres to impinge on fuel spray.
31. Hollow first-stage nozzle blades.
32. Hollow rotor shaft.
33. Primary air to inter-stage turbine labyrinth seal via hollow nozzle blades and slotted turbine disc bolts.
34. Four turbine disc bolts.
35. Turbine inter-stage spacer.
36. Solid second-stage nozzle blades.
37. All axial compressor and turbine blades and discs are machined from the solid.
38. Stepped labyrinth seal at rear bearing.
39. Rear roller bearing.
40. Turbine stub-shaft integrally bladed fan.
41. Rear-bearing support pillar.
42. Rear-bearing oil-delivery pipe.
43. Cooling air to rear bearing and stepped labyrinth seal via fan.
44. Three aerofoil vanes.
45. Gearbox cradle.
46. Power-turbine bolts.
47. Power-turbine labyrinth seal.
48. Ball bearing at front of power turbine.
49. Roller bearing at rear of power turbine.
50. Reduction gears.
51. Roller bearing at front of output shaft.
52. Stepped ball bearing at rear of output shaft.
53. Output shaft.



The two air-bleed outlets on this development A.129 are used for compressor testing.

BLACKBURN A.129 FREE-TURBINE ENGINE



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During its third test run the engine was taken up to its full speed of 35,000 r.p.m. and handled well; it gave 600 h.p. at a consumption of 0.85 lb./s.h.p./hr.

Development Plans

Development of the A.129 is at present directed towards early flight clearance for a possible installation in the P.531 helicopter by next March. The requirement is for an engine which will provide a power of 650 h.p. which is maintained for operation in hot, high-altitude conditions. This means that the engine will be, in effect, derated to give 650 h.p. in I.S.A. conditions, but this power will be maintained so that the helicopter's performance does not suffer when operating in hot countries and from high-altitude airstrips. The 650-h.p. restriction is set by the design strength of the P.531's transmission system. A 25-hr. special-category test for this constant-power engine will be completed before March.

In parallel with the development of this version of the A.129 will be work on the 840-h.p. version; this should be available for preliminary flying next spring and delivery in a fully developed form is planned for July, 1959. It will have a specific fuel consumption of 0.77 lb./s.h.p./hr.

The second stage of engine development will be the 970-h.p. version of the engine, which will have a specific fuel consumption of 0.68 lb./s.h.p./hr. Engines of this type should be available by December, 1959.

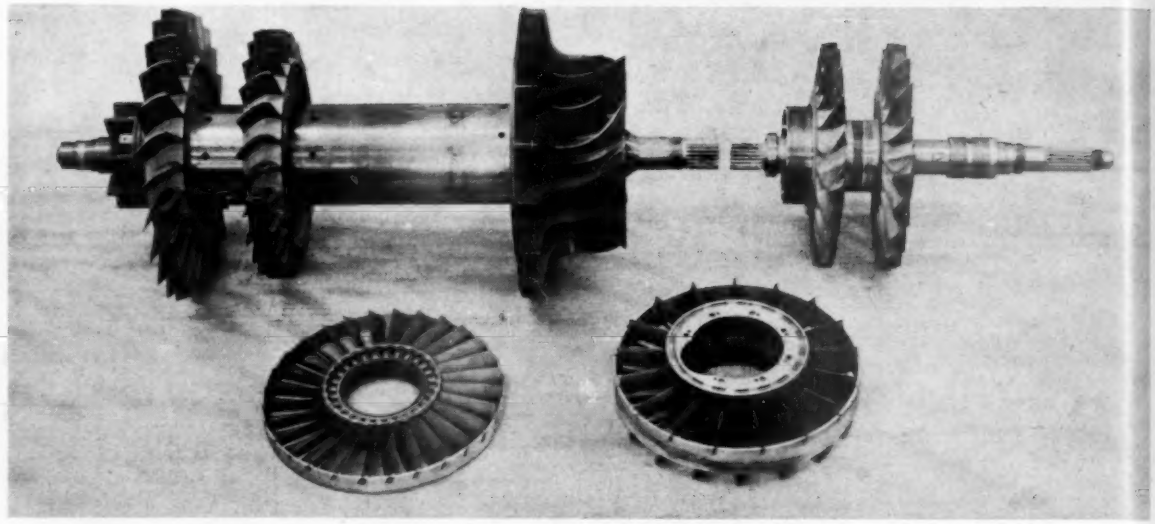
The Artouste 600, on which development of the A.129 has been based, is a 450-s.h.p. engine with a centrifugal compressor and a two-stage axial turbine mounted on the same shaft. To it has been added a two-stage axial compressor which has increased the overall pressure ratio of the supercharged engine so formed from the 4.0 : 1 of the Artouste to 6.35 : 1. This supercharged Artouste acts as the gas-generator section of the A.129, which has an axial free-turbine installation similar to that of the existing Turmo engine. The turbine stage itself is a completely new design as the engine's power is much higher than that of the Turmo.

In the A.129 the two-stage axial turbine of the Artouste 600 supplies all the power for the compressor but has no shaft power output except to the engine accessories. As a result, the second stage of this turbine becomes underloaded with a consequent drop in stage efficiency. But this second stage contributes only a relatively small part of the total turbine work and thus the drop in overall expansion efficiency is not serious.

This will be rectified in the 970-h.p. version of the A.129, for which the blading of both the turbine stages driving the compressor and the centrifugal compressor will be redesigned to give maximum efficiency. The specific fuel consumption will fall to 0.68 lb./s.h.p./hr., compared with 0.77 lb./s.h.p./hr. for the initial 840-h.p. version of the engine.

In developing the initial version of the A.129 from the Artouste the mass flow has been increased from 7.0 lb./sec. to 11.0 lb./sec. and the power from 450 s.h.p. to 840 s.h.p.; fuel consumption has been reduced by more than 25% from 1.05 lb./s.h.p./hr. Combustion intensity has not been increased and the maximum diameter of the engine remains virtually unchanged.

It might be thought that development of the new engine from



The main rotating assembly of the A.129 is made up of (right to left) three compressor stages—two axial and one centrifugal—and two axial turbine stages. The free turbine is not shown. Also in this view are the two shrouded stators of the axial compressor.

the Artouste would give a considerably more inefficient engine than if a new one were developed from scratch. In fact, studies show that this is not so and that the savings in development time and cost more than justify the Blackburn approach to the design of the A.129. Although, as mentioned, there are slight penalties in using the Artouste in an almost standard form, these will be eliminated in the second stage of A.129 development.

There is much scope for development of the A.129 beyond its 970-h.p. version. There is an inter-Services requirement for a helicopter engine which would give 720 h.p. at 7,000-ft. altitude and at I.S.A.+25° C. Although this is beyond the capabilities of the 970-s.h.p. version of the A.129, the engine could probably be developed to meet it.

A likely line of development is an increase of some 50° C. in its operating temperature, which would be possible if Nimonic 100 were used for the engine's turbine discs; this would increase power by about 100 h.p. The mass flow of the engine might also be increased by improving the performance of the axial compressor. This is a comparatively new design, with an efficiency of 85%. It should be possible to improve the efficiency by increasing the transonic Mach number over its upstream stage; this Mach number is at present less than that on at least one other well-known turbojet engine.

Another possibility for increasing the engine's power output is the use of air-cooled blading. This could be used if necessary, but is unlikely unless considered to be essential, as Blackburns aim to keep the engine as simple as possible.

Although the first applications of the A.129 will be on helicopters, studies have been made of its use as a turboprop engine for aircraft. Blackburn effort is at present almost exclusively military and it might well be logical for the company to enter the civil field with a transport, possibly of the STOL type, which embodied the A.129 engine.

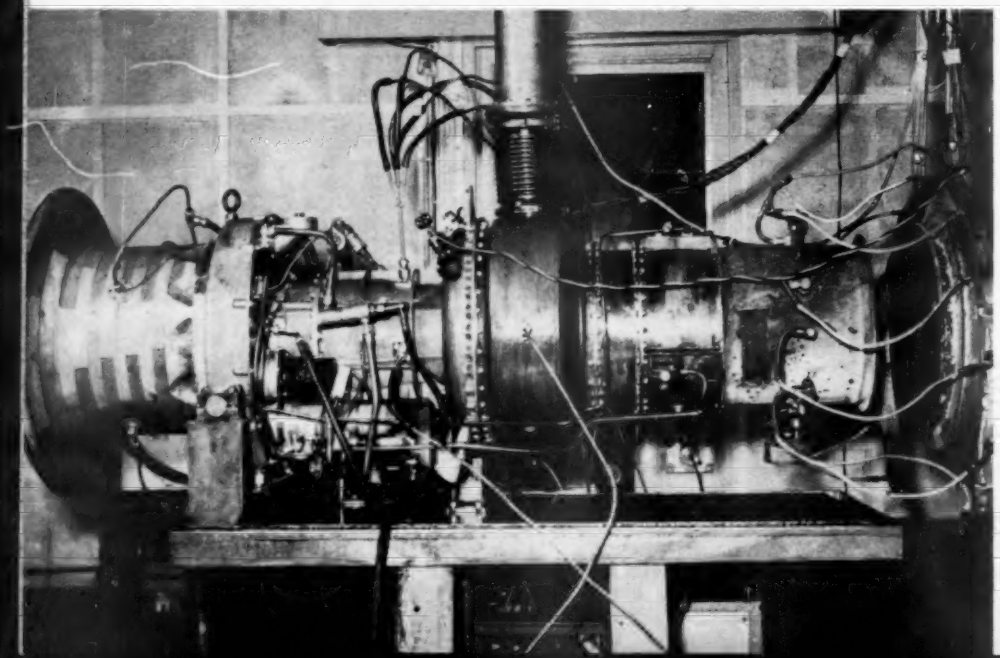
The current range of Blackburn engines is used mainly in the form of airborne auxiliary power units and air-bleed units for engine starting. The gas-generator unit of the A.129 could well form the basis of a new range of higher-powered air-bleed and auxiliary power units. The company has already had one inquiry for the A.129 as an auxiliary power unit; the lower-powered Artouste has been chosen as an airborne A.P.U. for a V-bomber and the Canadair CL-44 transport.

A.129 in Detail

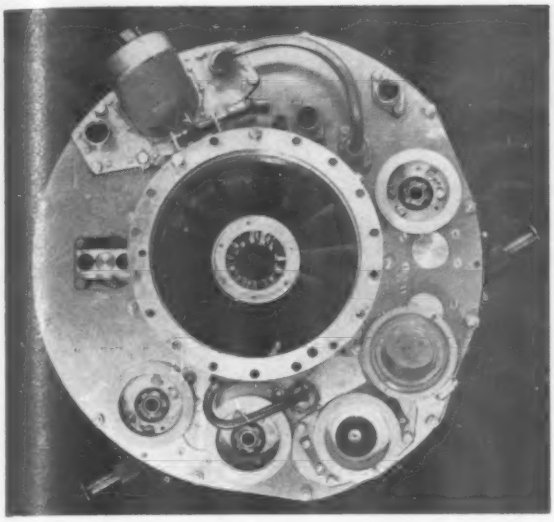
The two-stage axial compressor mounted ahead of the existing Artouste 600 engine has an annular intake. Its two compressor discs have integrally machined blades and integral stub shafts; they are bolted together to form a robust rotating assembly.

This is supported at the front on a high-speed roller bearing which is housed in the central cone of the annular intake and supported by three radial struts. The rear support of the compressor is a high-speed ball-bearing housed in a flexible case. The compressor shaft is driven directly from the Artouste via a serrated coupling.

Cast stator blades of the axial compressor are brazed to



This A.129 is under test in gas-generator form without its free-turbine. Compressed air is bled from it for the evaluation of compressor characteristics.



The variable inlet guide vanes on development A.129 engines are ganged together; their setting is controlled by the rotation of a master vane.

inner rings and slotted into outer rings when they are inserted into the light-alloy casing of the compressor. The casing is spigoted and is bolted to the annular intake of the centrifugal compressor casing.

Variable inlet guide vanes are fitted to development engines. Tests have shown, however, that these are unlikely to be needed on production engines, which will have fixed guide vanes.

The central rotating assembly of the engine is almost identical to that of the Artouste. It consists of a single-sided centrifugal compressor, which incorporates centrifugal fuel injection, and a two-stage axial-flow turbine and stub shaft. Because compression temperatures are higher than on the Artouste, the compressor is made of stainless steel, in place of light alloy. The turbine discs have integral blades.

The free-turbine assembly is similar to that of the Turmo 600, but the turbine and gearing have been redesigned to allow for the higher engine power. The hub diameter of the turbine is unchanged, but the tip diameter has been increased. Integral blading is used for the turbine, which is of Nimonic 80.

The annular combustion chamber of the Artouste is retained and, because of the higher operating pressure, combustion intensity is reduced. As with the earlier Blackburn engines, centrifugal injection of fuel is combined with combustion in an annular chamber.

Fuel enters the engine at its forward end through one of the three radial arms which support the front bearing of the axial compressor. It flows through a tube which passes down the centre of the axial compressor and into the hollow shaft of the main rotating assembly. The fuel enters the combustion chamber via radial holes in the rotor shaft. Carbon seals are used except at the front of the engine, where there is an air-pressurized labyrinth seal.

Engine accessories are mounted circumferentially around the axial compressor casing and are driven through compound and idler spur gears from a single pinion. The drive to this is via a 2 : 1 spur reduction gear from the high-speed pinion of the main rotor shaft through 1 : 1 straight bevel gears. The drive shaft passes through one of the three radial struts in the annular intake. Drives for up to 10 accessories can be provided.

From the foregoing it will have been seen that the A.129 is a simple, robust and cheap power unit bearing a close relationship to earlier Blackburn turbine engines. It has been developed as a private venture and there are high hopes that it will emerge successfully in the highly competitive field which today faces any new free-turbine engine in this particular power bracket.—J.R.C.

Technical Data

DIMENSIONS: Overall length, including free turbine and gearbox, 5 ft.; maximum diameter, 1 ft. 8 in.

WEIGHT: (Including single-stage reduction gearbox), 390 lb.

PERFORMANCE: Development Stage 1: Maximum power (5-minute rating), 840 s.h.p. at a specific fuel consumption of 0.77 lb./s.h.p./hr.; one-hour rating, 780 s.h.p. at an s.f.c. of 0.78 lb./s.h.p./hr.; maximum continuous power, 700 s.h.p. at an s.f.c. of 0.81 lb./s.h.p./hr.

Development Stage 2: Maximum power (5-minute rating), 970 s.h.p. at an s.f.c. of 0.68 lb./s.h.p./hr.; one-hour rating, 886 s.h.p. at an s.f.c. of 0.70 lb./s.h.p./hr.; max. continuous power, 815 s.h.p. at an s.f.c. of 0.72 lb./s.h.p./hr.

A B.O.A.C. TEST PLANT

A NEW aerodynamically designed, twin-cell test bed capable of accommodating prop-jet engines of 10,000 e.s.h.p. with propellers of 20 ft. dia. passing up to 4,000 lb. of air per sec., has been opened by B.O.A.C. at the Nantgarw test site of the Corporation's repair factories at Treforest, South Wales. The equipment is at present being used for testing the Proteus 705 engines of B.O.A.C.'s 15 Britannia 102s and the Proteus 755s of its 18 Britannia 312s.

The aerodynamic shape of the test section was specified by B.O.A.C. and it was constructed by British Reinforced Concrete in pre-stressed concrete 8 in. thick. An overall compression loading has been the aim, in order to reduce fatigue stress in the cell due to vibration. All the test equipment was designed to B.O.A.C.'s specification by Heenan and Froude, who also supplied the equipment and were responsible for its installation.

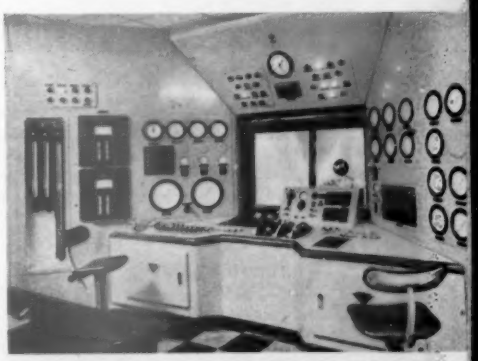
To reduce air flow obstruction the engine is carried on top of a streamlined column. This column in conjunction with its steel underframe will take the full power, weight and thrust of the power unit. It is also arranged so that torque reaction measuring equipment can be added later if necessary.

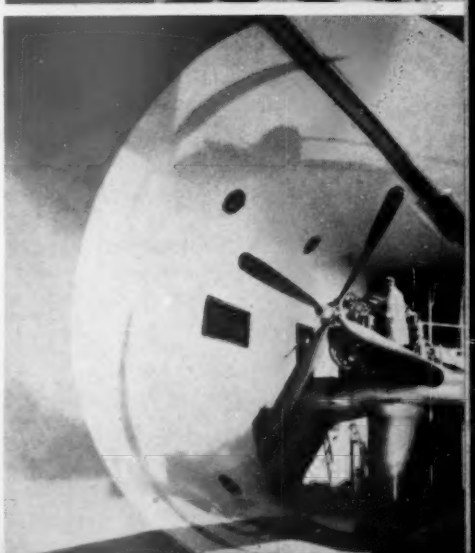
At each side of the column just below the engine are service ducts extending to the cell walls. These also act as engine access platforms from the control room and cell floor.

For propeller handling, a hydraulically operated platform is provided forward of the test stand. This stand has to be retracted to floor level before the engine is started and an electrical interlock prevents the engine from starting until the platform is fully down.

The control room is alongside the cell and has an observation window just above and a little towards the rear of the engine. Around the window is built the main control panel and this houses engine instrumentation, controls, indicator lamps and starting and switch panels.

The throttle control for the Proteus is the Ultra type similar to that installed in Britannia aircraft. The de Havilland propeller control is of the hydraulic type. At one end of the control room, forming an extension to the instrument panel, is the engine oil system cabinet. This houses two quite separate systems for different types of lubricating oils. Provision is made for heating, cooling and filtering the oils, and an inhibiting oil system is also installed for use at the end of tests.





Above, the control room of one of the two test cells in the B.O.A.C. engine test section at Nantgarw, Treforest, South Wales. Below, a Bristol Proteus turboprop being prepared for test.

The Fighting Services

R.A.F. Inventions

WINNERS of four awards made by the Air Council to R.A.F. personnel on the recommendation of the Ministry of Supply Committee on Awards to Inventors have been announced.

Wg. Cdr. K. H. Wallis, now on the armaments staff at Headquarters, Fighter Command, receives £150 for a modification to the 25-lb. practice bomb, which makes it safer and more efficient in operation. Warrant Officer F. J. Gow, at A. and A.E.E., Boscombe Down, has been awarded £25 for designing a tool for use in servicing airborne radar. M. Tech. A. W. Hawkes of R.A.F. Kinloss receives £50 in addition to £20 already granted by the A.O.C.-in-C., Bomber Command, for five suggestions which have saved considerable time in the servicing of refueller filter packs. Cpl. Tech. F. J. Edwards, now serving at R.A.F. St. Mawgan, receives £50 for a tool which saves some six man-hours per squadron weekly and reduces wear and tear on engine cowlings in the servicing of the Canberra's Avon powerplants.

I.A.F. CHALLENGE TROPHY.—To mark 25 years' association with the Indian Air Force, Rolls-Royce has presented a Challenge Trophy to the Service. The Trophy was accepted on behalf of the I.A.F. by H.E. Mrs. Pandit from Mr. J. D. Pearson, chief executive and deputy chairman of the company, at a ceremony in London earlier this month.

A Tie for Navigators

A TIE has been designed for past and present members of No. 2 Air Navigation School, and can be obtained from the Station Adjutant, R.A.F. Thorney Island, for 14s. post free. The tie is produced in terylene and its design consists of the No. 2 A.N.S. crest on a navy-blue background.

Flying College Commandant

AIR COMMODORE E. M. DONALDSON, C.B.E., D.S.O., A.F.C., has become A.O.C. and Commandant of the R.A.F. Flying College, Manby, in succession to Air Cdre. P. H. Dunn, C.B., C.B.E., D.F.C. Deputy Commander (Air), British Forces, Arabian Peninsula, since December, 1956, Air Cdre. Donaldson gained the World's absolute air-speed record of 616 m.p.h. for Britain in 1946, piloting a Meteor 4 from R.A.F. Tangmere.

In October of the same year he was appointed Senior Air Staff Officer, No. 12 Group, Fighter Command, and in June, 1949, became head of the Air Cadets Branch at Headquarters, Reserve Command. Early in 1951 he took command of R.A.F. Fassberg, 2nd T.A.F., and became Deputy Director of Operational Training (1) at the Air Ministry in April, 1954. Eight months later he was appointed Director of Operational Training.

Auxiliary Efficiency Trophy

THE 1958 Fighter Control and Radar Reporting Efficiency Trophy competed for by Fighter Control Units of No. 11 Group, Fighter Command, has been awarded to No. 3617 (County of Hampshire) F.C.U., R.Aux.A.F., at Bournemouth (Wg. Cdr. C. J. Simpson, D.F.C.). Second for 1958 was No. 3604 (County of Middlesex) F.C.U. (Wg. Cdr. A. R. Smallwood), third No. 3619 (County of Suffolk) O.C.U. (Wg. Cdr. F. N. Royle-Bantoft), and fourth No. 3618 (County of Sussex) F.C.U. (Wg. Cdr. F. Perrens, D.S.O., D.F.C.).

Awards for Technical Cadets

TECHNICAL cadets who sat for the 1958 examinations at the R.A.F. Technical College, Henlow, gained 21 awards of Higher National Diplomas in Mechanical and Electrical Engineering, the highest number since the start of the Technical Cadet Scheme in 1955. This brings the total awards up to 55, including 15 with distinctions.

Twelve cadets under the scheme graduated with degrees from the parallel university courses at Oxford, Cambridge and Bristol, which included one B.Sc. in aeronautical engineering. The rest were B.A. degrees in mechanical sciences, engineering science and engineering studies.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Group Captains: L. E. A. Dearberg to the R.A.F. Hospital, Ely, to command; J. B. Ross to Headquarters, Bomber Command, as Deputy Principal Medical Officer.

Wing Commanders: A. L. Cornford to R.A.F. Harpur Hill to command; D. I. C. Eyres to R.A.F. Uxbridge as a Board President, Ground Officers' Selection Centre; M. G. L. Foster, A.F.C., to R.A.F. Uxbridge as a Board President, Ground Officers' Selection Centre; T. W. C. Fazan to R.A.F. Driffield as Officer in charge of Administration; R. W. Hurst to R.A.F. Wellesbourne Mountford for administrative duties; P. C. Lambert to R.A.F. Hemswell to command No. 97 Sqn.; R. S. Mortley, A.F.C., to the School of Anti-Aircraft Artillery to instruct; G. Buckle to Headquarters, Eastern Atlantic Area, NATO, for exercise planning duties; A. M. Gill, D.F.C., to Headquarters, M.E.A.F., for operational staff duties; E. F. Hales to Air Ministry for duty in the Department of the Air Member for Supply and Organization; A. P. Morgan, D.F.C., to the R.N. Staff College for directing staff duties; R. E. Powell to Air Ministry for duty in the Department of the Air Member for Supply and Organization; R. A. Schofield to R.A.F. Horsham St. Faith for administrative duties; K. C. R. Smith to Air Ministry for duty in the Department of the Air Member for Supply and Organization; P. D. J. Wood, D.F.C., to Air Ministry for duty in the Department of the Air Member for Supply and Organization.

Squadron Leaders: R. W. Payne, A.F.C., to R.A.F. Wittering to command No. 49 Sqn. (with acting rank of W. Cdr.); W. G. Wood, to R.A.F. Feltwell for administrative duties (with acting rank of W. Cdr.); O. L. Hardy, D.F.C., A.F.C., to Air Ministry for duty in the Department of the C.A.S. (with acting rank of Wg. Cdr.).

AUXILIARY DINNER.—Members of one of the few remaining R.Aux.A.F. units—No. 3604 (County of Middlesex) Fighter Control Unit—held a dinner dance on December 11. The guest of honour, Viscount Templewood (third from the right), is seen seated next to the Unit's C.O., Wg. Cdr. A. R. Smallwood, R.Aux.A.F.

Control of Space

by Air Marshal Sir Robert Saundby

FOR many thousands of years man was able to move only in two dimensions, and the air above him, and still more the unknown space beyond it, was merely the sky, a firmament into which he never expected to be able to penetrate. As a result of this, a body of law grew up which was mainly designed to cover the ownership of land and property from any threats that might come from above or below it. It was therefore conceived that a landowner owned also the airspace over his property and the ground underneath it. Because of the difficulty of defining any limits to such ownership, Roman law decreed that a landowner's rights extended "*usque ad coelum et infra ad infernos*"—up to the heavens and down to the nether regions. In practice, however, these rights did not confer on every landowner a substantial piece of heaven and a little bit of hell. They chiefly served to confirm ownership in minerals, etc., found under a property, and to protect it from infringements from above.

Such infringements were usually the result of building or the cultivation of trees. For example, a man might build as high as he liked into the air over his own property, but he must not build projections which overhung his neighbour's land. Nor must he allow his roof to come so near to the boundary that rainwater could be discharged upon his neighbour's property. He must not allow the boughs of his trees to penetrate his neighbour's airspace and overhang his land. If he did so, the neighbour was entitled to lop them.

The ownership of the airspace above land conferred the right of trapping, shooting, and otherwise pursuing such birds as inhabited the airspace or were passing through it. Since man could not move through the air the offence of trespass was hardly practicable, but it would be illegal, for example, to build a bridge over a man's land and use it as a right of way.

Later, in the common law of this country, it became an offence to erect buildings, grow trees or do anything else which would interfere with a neighbour's enjoyment of his normal ration of sunshine and even daylight. This confirmed the principle that a man was entitled, not only to the free enjoyment of the airspace over his land and to such use as he could make of it, but also to the light and heat of the sun which came to him by way of it.

It should be noted, however, that under Roman law the rights of a sovereign state in practice were deemed to extend upwards as far as human control could be exercised. The rights of private property in airspace, on the other hand, were deemed to have an economic basis, and therefore the landowner's rights extended upwards only to the point at which he ceased to have an economic interest or purpose. These were, however, purely practical limitations which did not modify the theory that ownership extended to the heavens. But beyond these points the theory was, in those days, entirely academic.

The concept of private rights in airspace above land persists in this country today. It is still established law that any part of a building overhanging a neighbour's land is illegal, and it is not permissible to rob a man of the sun's heat and light by erecting obstructions, or to pass electric cables through the air above his property.

As long as mankind was confined to movement on the surface of the land and sea this legal conception was simple and effective. But in 1783 the brothers Montgolfier ascended into the air in a free balloon. Such a vehicle, once clear of the ground, must drift with the wind and the occupants are powerless to avoid traversing the airspace over other people's land. But in those days ballooning was regarded as an amusing diversion, and even the first international flight, from Dover to Calais in 1785 by Blanchard, attracted very little attention from the jurists.

As far as I can discover, the question of the control of aerial navigation was first raised by the Germans during the Franco-Prussian War of 1870-71. Paris was then besieged, and the French used balloons as a means of travel into and out of the city. The Germans claimed the right to shoot down these balloons, on the ground that the besieging forces had the right to control all means of access to the beleaguered city, including the airspace over the territory occupied by them. They did, in fact, succeed in destroying some of these balloons by artillery fire.

Though this spectacular incident attracted a good deal of attention, it did not bring about any change in the law of ownership of airspace, nor did it have much effect on military doctrines. Aerial navigation seems still to have been regarded as an exceptional and unimportant phenomenon, which did not demand any change in legal theory or practice.

At the beginning of the 20th century a French jurist put forward the proposition that the air above 1,500 metres should, like the sea outside territorial limits, be entirely free for navigation. This idea did not attract much support, and soon afterwards the Wright brothers flew the first powered aircraft at Kitty Hawk, in the United States of America. With the arrival of the aeroplane it was obvious that private ownership of airspace "up to the heavens" would create new offences of trespass, which would be not only difficult to deal with, but would be very restrictive of man's new power of flight. But the jurists did nothing about it, and it appears to have been tacitly assumed that, as conceived by Roman law, a landowner's rights extended, in practice, upwards only to the point at which he could exercise some economic interest or purpose. Thus, it was not practicable for a landowner to refuse to allow aircraft to pass over his land.

National sovereignty appears also to have conformed to the conception in Roman law, that the rights of a State extended upwards only as far as human control could be exercised. It was, therefore, permissible for a British aircraft to fly anywhere in the British Isles, or over the high seas, except for such areas as might be prohibited by the State. But it was not permissible for a French aircraft to fly over British territory, nor for a British aircraft to fly over French territory, unless specially authorized by the Government concerned.

This situation persisted until the end of the First World War. With the coming of peace it was obvious that civil air transports, although the larger oceans would still present a barrier to air travel, would soon be flying to and fro between many countries in Europe and in the American continent. A great

SPACE RESEARCH.—North American's X-15 research vehicle is designed to carry a man to a height of about 100 miles above the Earth, travelling at 3,600 m.p.h. It is scheduled to fly early in 1959.

conference was assembled in Paris in 1919, and a Convention "Relating to the Regulation of Aerial Navigation" was signed by no fewer than 38 States. In Article I of this Convention it was laid down that every State had "complete and exclusive sovereignty over airspace within its territory." The territory of a State was defined as "including the national territory, both that of the mother country and of the colonies and the territorial waters adjacent thereto." The Convention was followed by a series of bilateral arrangements between States allowing the civil aircraft of each to fly over prescribed parts of the territory of the other for the purpose of carrying goods and passengers.

Crossing National Frontiers

With regard to military aircraft, the position was rather obscure and unsatisfactory. Generally speaking, the flying of military aircraft over the territory of another State, however friendly, was of rare occurrence, and special permission had to be obtained for each flight. Such permission was not always readily forthcoming. In war-time, aircraft were not allowed to fly over neutral territory, and if they did so the State concerned might order them to land, or shoot them down, and intern any aircrews that fell into its hands.

This was the position during the Second World War, but by the end of that War a new factor of great importance had appeared. Hitherto all aircraft had flown through the atmosphere and, for the most part, through the lower reaches of the atmosphere up to heights of 30,000-35,000 ft. Up to these heights sovereign States might fairly claim that they had some control, and were therefore entitled to exercise their jurisdiction. But the Germans had developed the V.2 rocket, a vehicle carrying an explosive warhead, which ascended to a height of 100 miles or more, and over which no method of control existed or could even be visualized.

In spite of this, a conference of thirty-seven States at Chicago, in December, 1944, signed a Convention which, in Article I, repeated the doctrine laid down in the Paris Convention of 1919. It reads as follows:

> "The contracting States recognize that every State has complete and exclusive sovereignty over the airspace above its territory."

The delegates to this conference seem to have restricted their deliberations to flight in the atmosphere. The use of the word "airspace" in Article I is significant, and it has been held to limit the jurisdiction of a sovereign State to the upper limit of the atmosphere. This limit is not easy to define, but it would appear to be approximately 120 miles above the surface of the Earth. It is rather surprising that the conference should have taken this attitude, but it may be that they then believed that even rockets were unlikely to go higher than about 120 miles. On the other hand, some support is given to the view that the delegates neglected to consider rocket developments by the fact that throughout the Convention the word "aircraft" is used to designate the vehicle to be regulated.

The apparent decision to use the atmosphere as the limiting upward point of national sovereignty has, in itself, been the cause of confusion and uncertainty, since scientists differ in their estimates of the height to which it extends. But, before the invention of the rocket, this would not have mattered very much. No conventional aeroplane can operate in the extreme upper reaches of the atmosphere, because there is not sufficient density of air at that height to support its weight by aerodynamic reaction, or to supply oxygen to an engine burning any form of oil fuel. And though it is true that it may be possible to reach a point near the upper limit of the atmosphere by means of a lighter-than-air craft—some form of balloon—it seems very doubtful. What is perfectly clear is that rocket-driven vehicles can, and will, frequently penetrate to heights far above those reached by the most tenuous atmosphere, and will therefore place themselves beyond the jurisdiction of sovereign States over whose territory they may pass.

It seems most unlikely that this was intended, or desired, by the thirty-seven States that signed the Chicago Convention. Recent developments in rocket vehicles and satellites have produced a crop of suggestions for defining the upper limit of national sovereignty in space, all more or less impracticable. The only realistic policy would seem to be to revert to the original conception of "*usque ad coelum*," pure and simple. But even this would involve theoretical absurdities. For example, the space above a country is defined by a series of lines, originating at the centre of the Earth, and passing through the national frontiers or territorial waters. These, if extended upwards indefinitely, would enclose a volume of immense—I suppose infinite—size, through which would pass, as the Earth revolves, whole universes and galaxies of suns with their solar systems. But it will, no doubt, be a long time, if ever, before such a consideration has any practical significance.

What, I suggest, nations now have to consider is whether or not they wish to extend their jurisdiction upwards to include the passage of rocket-driven vehicles, which may be at an altitude of several thousand miles. The question falls naturally into two divisions, peace and war. It might be argued that if, in peace time, nations wish to project into space rockets or satellites which will pass over our territory too high for us even to see them, it is a matter of small concern to us. Whether that view is sound or not depends upon what these rockets or satellites are capable of doing. Many distinguished military leaders, among them Lord Montgomery, and General James Gavin of the U.S. Army, believe that such space vehicles have vast possibilities for intelligence purposes. They believe that they can be used for aerial photography, television relays, and so forth. Since there is at present no way of capturing or destroying such vehicles, the only way of preventing such applications would be to put all space vehicles under effective international control.

The same authorities believe that, in time of war, satellites could be used to launch and direct missiles carrying "A" or "H" bombs to any target on the face of the Earth.

It may be reasonably contended that no upward extension of national sovereignty is of any practical value so long as no means are available for controlling or destroying rockets and satellites of foreign origin which are passing over our territories. It would be rash to conclude that no such means will ever become available, but it seems safe to assume that they will not be available for some considerable time.

We are therefore driven to examine the possibilities of international control of all activities in the region which lies beyond the Earth's atmosphere. General Gavin advocates that this control should be vested in the United Nations.

It must, however, be admitted that our experience of international control, up to the present, has been far from encouraging. In the first place, the United Nations is not a Court of International Law; its judgments tend to be swayed by national rivalries, ambitions, and prejudices. It is given to illogical compromises and ambiguous pronouncements. It frequently fails to intervene effectively in matters which are its direct concern, and as often interferes in matters which are outside its province. Secondly, when it does issue a clear injunction it can be successfully defied, when it suits them, by the Communist bloc, or even on occasion by a nation as inconsiderable as Egypt. The United Nations would have no more power of controlling satellites or rockets, launched with malevolent intentions, than would any of its constituent members.

Clarifying the Position

Yet some international agreement is obviously desirable. A new Convention seems to be required, if only to clarify the peace-time legal position. A possible development might be to place, on the State which launched it, the legal responsibility for the control of any space vehicle, including the liability for compensation for any damage or inconvenience it may cause. It might be possible to set up a United Nations organization to allocate and control orbits and zones in space in something of the same way that radio frequencies are controlled today.

But the supreme question, the prevention of the use of space for mischievous, aggressive or military intelligence purposes, appears almost insoluble. The only hope would seem to be that a mutual fear of the evil consequences, the threat to all nations on Earth regardless of size or geographical position, might bring about a genuine agreement to renounce all such practices. But, in the light of our experiences with nuclear weapons, it is not possible to put much faith in such a development.

It is far more likely that we shall drift on, with no agreement, into a competition for the military use of space. If this should happen, the most we can expect would be a stalemate similar to the nuclear stalemate which now seems to be inevitable, adding another shadow to those which already cloud the future of humanity.

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Book Reviews

THE AIR FORCES OF THE WORLD (Their History, Development and Present Strength). By William Green and John Fricker. 366 pp., 9 in. by 11¼ in. Illustrated. Macdonald and Co., Ltd. Price 60s.

THIS VOLUME brings together 82 different air forces, from the mammoth U.S.A.F. and U.S.S.R. arrays to the midget forces of San Salvador and the Sudan. Each State is arranged alphabetically and delineated by a map showing its military airfields, with the notable exceptions of Soviet Russia and Communist China. There are no maps for these two States, and Western students will be disappointed to find no such information. But maps and keys show every military airfield in the respective home territories of the U.K. and U.S.A.

One wonders how much intelligence value such publications offer to the Eastern bloc? Their value to the intelligence branches of the Western Powers is obviously much less. If not essential to Communist intelligence, such publications can be of great instructional value in Communist military schools, which need only copy the information given about the West to provide their students with useful military data. I would venture to guess that this volume will find purchasers in the Soviet Embassy for use in Russia and Communist China by military students.

Abbreviated histories of each air force appear in the text. In the available space it has been impossible for the authors to be comprehensive and one notices gaps, such as the omission of the use of the Avro 626 advanced trainer by the Argentine Army in 1932-36, and the omission of the Fox as the R.A.F.'s most advanced day bomber in 1926-30. Credit is wrongly given to the Hart instead of the Fox as the aircraft that first outspeeded contemporary fighters. The Hart was four years later than the Fox in coming into service; it was, in fact, inspired by the Fox, which ought to have received the laudation given to the Hart.

While the text covers each air force historically, the photographs are all of types in current use. Thus, the picture cover is not historical. It is, however, copious and of good quality from well-chosen pictures. There are no pictures of weapons, other than air-to-air guided weapons such as the D.H. Firestreak mounted on aircraft. One could have expected some pictures of Air Force weapons like the Bloodhound and Thunderbird, Rascal, Bomarc, Snark, Thor, Atlas and others which are the prerogative of Western air forces. Some of these weapons are briefly referred to in the text, perhaps too briefly.

The air forces of the U.S.A. are sub-divided into the U.S.A.F., the Naval and Marine Corps, and Army Aviation, and this is well done and makes for easy reading and reference. Unfortunately, the R.A.F., Fleet Air Arm, and Army Air Corps are all run together and the last is not even mentioned in the heading. As a result, the history of British military aviation is less clear and convenient for reference.

Each section is headed by the headquarters and commander of the force. But in some cases the commander may be due for early replacement and his inclusion is chiefly interesting in showing relative ranks for the job, from captain in the Sudan to general in U.S.A. and marshals in the U.S.S.R. and the U.K.

Nine pages of colour plates show the insignia of the air forces, and a 2-pp. index lists the aircraft pictured. The absence of an index for the text reduces the ready use of the volume for reference to the short histories themselves. The format is of library character; the book weighs 3¼ lb.

One must admire the industry of the authors in collecting the encyclopædic information arrayed in "The Air Forces of the World." They have done a useful service in providing a convenient means of comparison of the various military air Services up to the end of the manned-aircraft-only period of their existence, but the book does not present a current picture of the actual offensive/defensive state of the major air forces because of the omission of unmanned air-force-operated weapons in their present state of deployment.

After making the necessary allowances for the limitations of its own ambitions, this book is a fascinating collection of World-wide information and will arouse the interest of those into whose hands it comes.—NORMAN MACMILLAN.

"AERODYNAMISCHE PROFILE." By Friedrich Riegels. 278 pp., 8 in. by 11¼ in. Illustrated. R. Oldenbourg. Price, 138 DM.

THE GERMANS are justly renowned for their Teutonic thoroughness. "Aerodynamische Profile" gives subsonic and transonic aerofoil data with a wealth of detail that is surprising, even for a German publication.

Although the book is written entirely in German, the non-German speaking technician will have little difficulty in using the second half of the book, which consists entirely of tabulated and plotted aerofoil data, with a minimum of headings and titles.

The other astounding feature is its high price (DM.138—say £11). One realizes that most aircraft flying this side of the Iron Curtain are designed by the English-speaking peoples, and one can only conclude that a very limited edition is planned for this book in German, due to the limited number of aircraft design teams.

The book includes 539 illustrations and 45 tables. Pre-War and war-time work in Germany, much of it previously unpublished, is combined with post-War work from other countries.

The first chapter defines wing profiles (aerofoil sections). The shape of 356 aerofoils is shown, and 76 references given in this one chapter alone; Chapter 2 describes the various wind-tunnels used to measure the published results, giving all salient dimensions, speeds, pressures and turbulence levels; the third chapter discusses the measurement of forces and moments, and the influence of Mach and Reynolds numbers thereon.

Chapter 4 deals with various matters. A detailed pitot traverse behind the FW 190 wing is of interest as showing the effect of protuberances on the drag locally. Chapter 5, dealing with wings with flaps, is short, but has an excellent list of references; and boundary-layer suction receives attention in Chapter 6.

Chapters 7, 8, 9 and 10 all deal with aerofoil theory, starting with inviscid incompressible flow in 7 and 8 in rigorous mathematical form. The effects of laminar and turbulent boundary layers are considered in Chapter 9. This is an interesting chapter in that it considers boundary layer stability and the influence of compressibility in some detail.

Chapter 10 develops supersonic aerofoil theory, Ackeret first order and Busemann second order approximations.

This concludes the 126 pages of two-dimensional aerofoil theory; the larger part of the book is devoted to tables (Chapter 11, 76 pages) and graphs (Chapter 12, 76 pages). It is this second half of the book which will interest English-speaking technicians.

The tables start with ordinates, surface slopes and surface velocities of hundreds of NACA and Göttingen sections, and dozens of others including N.P.L. and R.A.F. In 11.5 we have tables of drag and lift coefficients as measured at various incidences.

A knowledge that C_a stands for lift coefficient and C_w for drag coefficient will enable most English-speaking aerodynamicists to read these tables without difficulty. Remember that coefficients and numbers (Reynolds and Mach) are independent of c.g.s. units. The high values of drag coefficient quoted for some Göttingen aerofoil sections are due to Reynolds numbers as low as 72,000. The DVL results are quoted for R=2.5 millions or so. In 11.6 we find a useful summary of flapped and slotted sections.

Coming now to the graphs in Chapter 12, we find velocity and pressure distributions plotted four to the page. Drag-lift polar diagrams are followed by compressibility effects.

Summarizing, one finds everything about aerofoil sections and nothing about the rest of aerodynamics; but how many people are interested in two-dimensional work to the extent of £11? If at first sight the book appears to be a little out of date, it must be remembered that little new has occurred in two-dimensional work in recent years. In particular, aerofoil section is not a significant variable at supersonic speeds in the absence of sweep-back.—W.F.H.

Hypersonics in Birdcage Walk

AS briefly mentioned last week, a full-day discussion on hypersonics was held by the Royal Aeronautical Society on December 15 at the Birdcage Walk headquarters of the Institution of Mechanical Engineers. Eight introductory papers were read and followed by discussions.

Although the aircraft industry was fairly well represented in the audience it was perhaps inevitable that all the papers and most of the discussion should come from members of research establishments or universities. As a result this conference was perhaps on the whole of more benefit to the hypersonic experts than to those who came to gain knowledge of hypersonics and their practical applications.

A glide vehicle of this shape was proposed by Mr. T. R. F. Nonweiler for manned re-entry from a near-circular orbit.

One difficulty which affected experts and non-experts alike was the absence of preprints of the talks. It was this fact no doubt which tended to limit the scope of the discussions. Another drawback was that the lecturers, who were usually hard pressed for time, would say "I haven't time to discuss this point, but it is covered in my written paper." These written papers were not available; they will be published in due course by the R.Ae.S.

It is impossible to summarize the talks and discussions in any detail, but some of the interesting points made appear below:—

Hypersonic Aerodynamics

Real-gas effects are among the major complications of hypersonic flow; stagnation temperatures and pressures are greatly affected by dissociation.

In design for the alleviation of kinetic heating there are two distinct cases. These are the uncontrolled re-entry of a freely falling body and sustained hypersonic flight. The first case has been considered in detail by Allen and Eggers in NACA reports (THE AEROPLANE, February 28, 1958); the main conclusion is that if the body is relatively light it is best to have a high pressure drag so that most of the heating is dissipated in the wake.

For sustained flight, a low pressure drag is preferable with radiation giving control of the surface temperature. There is a good hope of achieving low-drag shapes; the main heating difficulty will be at the leading edge. Sweepback could be used to reduce both drag and leading-edge heating.

MR. R. J. MONAGHAN mentioned R.A.E. tests which are now being made at Mach 7 with arrow-head lifting bodies which have leading-edge sweepback of 70°, 80° and 85° respectively. These tests were being made at a high angle of incidence. The bodies were symmetrical, but camber could be added to them. They represented a trend of designing from lower Mach numbers upwards.

The other trend in design was from high Mach numbers downwards; the idea here is to make the greatest use of separated flow. An example is a hemisphere to which is attached a nose spike at which the flow separates. Drag is much less than on a hemisphere without a spike, but the heating might be greater.

Mr. Monaghan concluded by emphasizing three points—that real-gas effects could modify flow fields greatly; that heating and aerodynamic efficiency were not necessarily incompatible, and that it was essential for hypersonic theory to be backed by experimental work.

In his survey of experimental facilities and measuring techniques, DR. D. W. HOLDER showed that for full simulation of the high temperatures of hypersonic flight it was usually necessary to use tunnels with a very short running time or to launch models at high speed. In hypersonic tunnels the working gas is usually heated by compression in a shock wave or a system of shock waves, or by the discharge of electrical energy.

All measurements of aerodynamic loading and heat transfer on the model must be made during a very short period of steady flow lasting only about 50 micro-seconds. In this time it might also be necessary to measure the degree of dissociation and ionization of the gas. An improvement in measuring techniques was needed and also, if possible, an extension of running times.

In speaking of the future of hypersonic research, Dr. Holder emphasized the need for a study of future requirements so that the appropriate test facilities could be designed.

MR. R. N. COX surveyed theoretical work on hypersonic flow and claimed that the pressure distributions predicted by Newton's particle concept had not been greatly improved by later study. This statement was challenged in the discussion.

He pointed out that for high Mach numbers the flow field "freezes" and the flow fields for blunt bodies remain unchanged with increasing speed. A diagram was shown of the flow round a two-dimensional wedge which remained unaltered between Mach 7 and an infinite speed.

DR. K. W. MANGLER, in discussing the production of lift at high speeds, spoke of the need to produce vortex sheets. Steps on the afterbody could be used to produce vortex sheets, and hence downwash.

DR. L. F. CRABTREE discussed the kinetic heating of slender bodies at hypersonic speeds; he showed that blunting of the leading edge is necessary to reduce excessive heating and to provide material for heat conduction. He indicated the advantages of transpiration cooling, which could reduce heat-transfer rates with a turbulent layer to less than those with a laminar boundary layer.

Magnetohydrodynamics

Currents in an electrically conducting fluid can, in the presence of a magnetic field, produce forces on the fluid. MR. J. A. SHERCLIFF spoke of the way in which magnetic fields could be used to influence ionized airflow through which a current was passed. By this technique it should be possible to produce extra drag away from the surface of a hypersonic vehicle so that the surface heating usually associated with drag was not experienced. Other applications might include directional control of vehicles and drag reduction by the suppression of turbulence. Another suggestion was that ionized gas moving past a vehicle could act as a dynamo to supply power for auxiliary systems.

The weight penalties of electromagnetic gas accelerators were emphasized and, in Mr. Shercliff's view, their most suitable application may be in ground-based test plants

Re-entry Vehicles

MR. T. R. F. NONWEILER discussed the design and performance of manned vehicles intended to re-enter the atmosphere from near-circular orbits. He considered two spheres intended for zero-lift re-entry and a glide vehicle which used lift to reduce both deceleration and aerodynamic heating.

Both spheres would have a maximum deceleration of 8*g*. One, the radiation vehicle, 14 ft. in dia., would be designed to have the lowest possible density; this was considered to be about 1 lb./cu ft. The vehicle would have an equilibrium surface temperature of 1,150° C. during re-entry.

With the sphere designed for heat absorption it paid to design for high density and thus to decelerate at low altitude. A 7-ft. diameter sphere was chosen, with a beryllium heat sink. For landing both spheres would be supported by parachutes.

The most profitable re-entry vehicle was considered to be a glider. An all-wing delta of wedge section was chosen; its shape is shown above. With this glider re-entry would be made at an incidence of 45° or more and the lower surface would carry almost all the aerodynamic loads and heating. The vehicle would take about 20 min. for re-entry, compared with 1¼ min. for ballistic re-entry of the spheres, but the peak *g* would be lower.

In designing the glider steel would be used, with a chrome-molybdenum nose projection to carry the peak heat loads. Stiffness would be the main structural criterion, as the equivalent air speed during re-entry would only be 80 ft./sec.

Mr. Nonweiler emphasized that he did not consider that this re-entry glider should be a sophisticated aircraft: it should be considered expendable, with the pilot ejecting from it before impact with the ground.—J.R.C.

The Eight Papers Discussed

"Problems of Hypersonic Aerodynamics—A Survey," by R. J. Monaghan (Aerodynamics Department, R.A.E.); "Experimental Facilities and Measuring Techniques," by Dr. D. W. Holder (Aerodynamics Division, N.P.L.); "General Characteristics of Hypersonic Flow Fields," by R. N. Cox (Atomic Research Development Establishment, Fort Halstead); "Some Special Aspects of Hypersonic Flow Fields," by Dr. K. W. Mangler (Aerodynamics Department, R.A.E.); "Boundary Layers, with Special Reference to Aerodynamic Heating," by Dr. L. F. Crabtree (Aerodynamics Department, R.A.E.); "Physics of Real Gases," by Prof. M. J. Lighthill (University of Manchester); "Magnetogasdynamics and Its Possible Aeronautical Applications," by J. A. Shercliff (University of Cambridge); "Aerodynamic Problems of Manned Space Vehicles," by T. R. F. Nonweiler (Queen's University, Belfast).

Missile Target Aircraft

ON December 17, MR. H. G. CONWAY, a director and the chief engineer of Short Brothers and Harland, Ltd., discussed the provision of target aircraft for missile development and training, in a lecture before the Guided Flight Section of the Royal Aeronautical Society. In his talk he surveyed the factors affecting the design and operation of target aircraft.

The three main duties of target aircraft are research work, reliability-proving and Service training. It is probable that attacks from operational heights above 50,000 ft. can be achieved today, and in future long-range attacks at increasing speeds and altitudes well in excess of 60,000 ft. must be catered for.

But low-level high-speed attacks over relatively short distances must not be ignored. Reasonably true representations of such targets should be available for a full and detailed evaluation of guided-missile performance.

The second factor dictating the provision of target aircraft is missile reliability. It is probable that nothing less than 200 or 300 firings of a typical missile system against real targets are necessary to ensure that the missiles have an adequate reliability under field conditions. In the opinion of Mr. Conway the modern tendency to argue that simulation studies or practising with dummies can take the place of the real thing is extremely dangerous and pernicious.

The third purpose of target aircraft is for training. While much of this, particularly servicing and handling, can usefully be done with dummies, the final requirement is a live firing.

Target Types

Existing target aircraft can broadly be classified into four categories. First come the small and cheap low-performance targets which are still in demand. Typical are the French CT.10, which has been developed from the V1, and the American Radioplane OQ-19. These targets have a low speed and ceiling and an endurance of up to about 1 hr. They can usually be launched from a rail system and recovered for future use.

In a second category are drone versions of surplus or obsolescent aircraft. These are widely used to provide realistic targets. In Britain we have the Firefly 5, the Meteor U.15 and U.16, and the Canberra U.10 aircraft based on conversions of obsolete marks of these aircraft. U.S. examples are the QB-17 and the QF-80 Shooting Star, with the QB-47 coming along as a new requirement.

The Meteor is a good modern target in this category with a ceiling of about 35,000-40,000 ft., an endurance of about 1¼ hr. and a maximum speed of about 450 m.p.h.; it is also relatively cheap. The Canberra is more ambitious and is relatively expensive, although justified on account of its more representative size and good altitude performance. But surplus aircraft are always of necessity one generation behind the enemy aircraft which they simulate.

In a third category are small, specially built targets which represent an extension of the first group considered; they have a more advanced performance although remaining relatively cheap. Such targets, designed for reliability-proving and training, include the Australian Jindivik, the French CT.20, the Ryan Firebee and the Radioplane RP.77. All are subsonic with an endurance of about an hour; they are rail-launched and use parachute recovery. They are cheaper than drone aircraft and thus preferable for training.

The last group covers the supersonic targets. Because the development of supersonic target aircraft would be prohibitively expensive, and because there are no surplus supersonic aircraft, it has been necessary to develop special small supersonic targets which are similar to missiles and use rocket motors or ramjets. This is a relatively new development; the Lockheed Q-5 is a typical example.

Performance Considerations

Aerodynamic manœuvre performance, both of the target aircraft and the attacking missile, falls off considerably with altitude. Instead of building a target to operate at the correct altitude for which the missile is being designed, it might be argued that simulation at a lower altitude was possible. This presents many practical difficulties.

Missile response, which involves inertia and height-dependent aerodynamics, cannot be kept the same. Active and semi-active guidance systems are very dependent on responses and to retain the correct simulated response, modifications must be made to the missile.

In a controlled cruciform missile cross-coupling effects will be more pronounced at high altitude where high body rates and angles are involved. The proving of the missile, at least in the research phase, must therefore include attacks at representative high altitudes.

Target size is of considerable importance to the missile radar-control or homing system. Although there are artificial methods of simulating glint or scintillation these are limited by the physical wing span of the target. It may be possible to determine from a few test results that the missile system works satisfactorily with a simulated reflecting area and that only a part of the research work must be done on a representatively large target. This seems particularly true of fuse trials; there can be no guarantee until actual tests have been made that the fuse will work satisfactorily on both large and small targets.

Steady target speed is not of great consequence, mainly because of the relatively high speed of the attacking missile; but manœuvrability must be representative. Broad bands of speed are all that seem to be neccessary, e.g., low subsonic, high subsonic and supersonic (approximately M=2).

In practical trial conditions, the target aircaft may be asked to hold off in case last-minute difficulties prevent the missile being fired at precisely the right moment. The ability to orbit in the sky for anything up to 2-3 hr. is a considerable advantage in the practical use of targets and is one reason why ground-launched supersonic targets are not likely to find much favour for some time.

On the other hand an air-launched missile target will allow the radar-tracking system of the missile to lock on to the mother aircraft carrying the target for the simulation of attacks from long range. Air launching then simulates the final phase at the appropriate altitude.

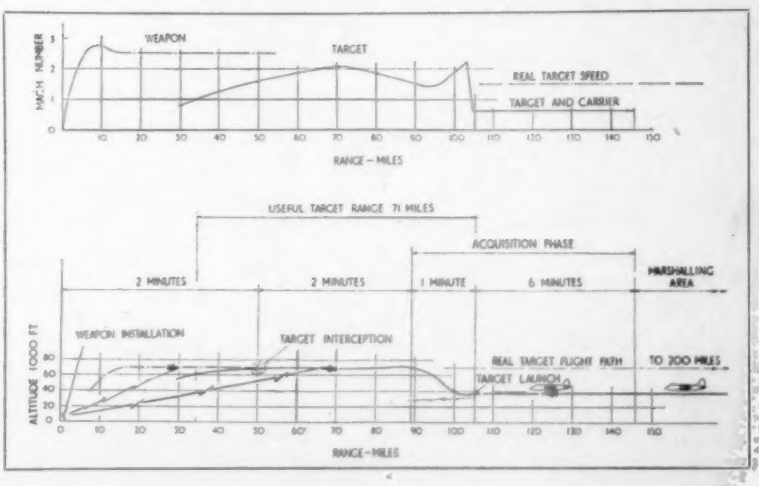
The Canberra U.10 is a conversion of the early B.2-series aircraft. The anticipated life of each converted aircraft is 300 hr. The two major changes in the Canberra, apart from the installation of the subsidiary automatic control equipment, are the fitting of an autopilot and of cameras, radio and radar equipment for miss-distance indication.

The full performance envelope of the basic aircraft is maintained, giving speeds of about M=0.8 at an operational ceiling above 55,000 ft., and an endurance of about 3 hr. Probably no current target aircraft can exceed 50,000 ft., the main justification for development of the Canberra U.10 is its excellent performance at altitude.

Future Needs

Targets will be needed to fly both at low level and at supersonic speeds. A low-flying target should fly below 300 ft. at speeds of 450-500 knots. An accurate height-lock system would be necessary.

A hypothetical study has been made by Shorts for adapting a typical surface-to-air missile test vehicle to act as a target, carrying it in a bomber and air-launching it at height. This could give speeds approaching M=2 and durations at well above 60,000 ft. of about 3 min. when launched from 40,000 ft.



This hypothetical Short study shows how a typical missile research test vehicle could be used as an air-launched target. The speeds, ranges and endurance shown will repay close study.

Polish Sailplanes

by Peter W. Brooks, B.Sc., A.C.G.I., A.F.R.Ae.S.

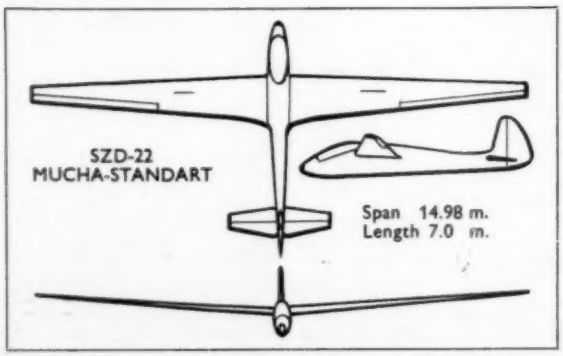
BEFORE the War Poland established a reputation second only to that of Germany as one of the World's leading gliding nations. The Poles won this position not only by the scale and achievements of their gliding movement but also for their leadership in sailplane development. However, the War put an end to all gliding in Poland. It also dispersed the technicians who had been active in the field of sailplane design and manufacture so that the revival, when it came in 1945, had to be started completely from scratch.

In spite of this, because the Government took the view that gliding should be sponsored as a national sport, Poland today probably leads the World not only in the size of its gliding movement but also in the scale and achievements of its national glider-manufacturing industry.

The Poles are understood to have manufactured some 2,700 sailplanes since 1946 and there are said to be some 800 gliders in use in Poland at the moment. Allowing for a slow start in the early post-War years and for normal wastage at the home gliding centres, these two figures suggest that Poland may have been exporting as many as 200 gliders per annum in recent years. A large number of these have apparently gone to China, which is now also building Polish designs under licence.

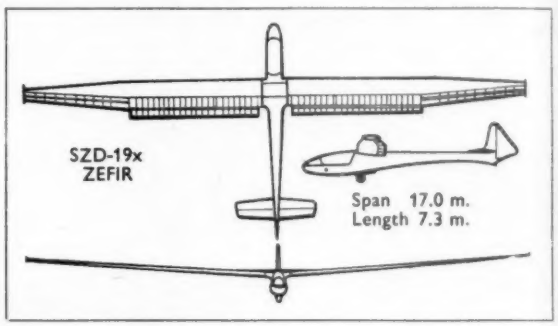
These are unofficial figures but, even if they are on the high side, there is little doubt that sailplane development has gone ahead in Poland in recent years on a larger scale than in any other country—and this includes the Soviet Union, which has presumably been too preoccupied with the more serious aspects of aviation to devote much attention to what is only a sport. The accompanying Table I gives details of the designs produced by the national experimental glider establishment at Bielsko-Biala in Southern Poland, which has been responsible for most of the design work. The Mucha, ABC, Jaskolka and Bocian designs have been produced in the largest numbers, together with two well-known pre-War designs, the Salamandra and Komar.

The writer first had contact with the reviving post-War Polish glider-manufacturing industry when taking part in an international soaring meeting at Samedan, Switzerland, in July, 1947. At that time the Iron Curtain had still not descended and the Poles were taking tentative steps to establish contacts with the West. It was therefore quite natural that they should appear at Samedan. However, technically the appearance of a Polish team with a new high-performance sailplane of native design was quite a remarkable achievement for a country which had suffered the devastation and disorganization which had been Poland's fate during the War. The Poles at Samedan had with them the Sep prototype, which had flown for the first time only the previous month and was the first product of the Bielsko-Biala establishment, which had been formed in an old furniture workshop, as the Gliding Institute (Instytut Szybowinitwa), in April, 1946. The Sep prototype had rather ineffective leading-edge dive brakes and a number of other not too satisfactory features; but, flown by Adam Zientek—who was to become one of Poland's most outstanding post-War glider pilots—it gained eighth place at Samedan and the type was put into small-scale production in the autumn of the same year.



The following year (1948), the first post-War International Gliding Championships were also held at Samedan, but this time the Poles did not put in appearance—the separation of East and West had come about. The Poles, however, were making steady progress in the rebuilding of their glider industry and this has continued at a healthy rate ever since. Polish gliders were not to be seen again in the West, however, until the 1956 International Championships at St. Yan, in France.

A visit to Poland this summer, to attend the 1958 Championships at Leszno, at last provided an opportunity to assess what the Poles have done during the past 11 years. Eleven SZD Jaskolka high-performance sailplanes (four SZD-8 bis and seven SZD-ter) were flown by the Polish and Russian teams in the Championships as well as by a number of visiting Western pilots. The Jaskolka Z (the SZD-8 ter model, which has water ballast tanks and radio) was one of the Polish designs seen at St. Yan in 1956 and is now well known. Some have also been exported to Western countries. Indeed, the various Jaskolka



types have probably been built in larger numbers than any other high-performance sailplane designed since the War, if one excludes the less advanced Mucha series of training sailplanes, which are also Polish.

An interesting point about the Jaskolka is that the original prototype gave a lot of trouble because of undesirable spinning characteristics. The spin was very flat and stable. After many "fixes" had been tried unsuccessfully, the fuselage of the production aircraft was lengthened by 68 cm. and this cured the trouble.

In addition to the 11 standard Jaskolkas competing at Leszno, there was on the aerodrome an example of the experimental SZD-17X development of this design. The Jaskolka L, as it is called, is the version with a laminar-flow wing section (NACA 65,512A) of which we heard rumours at St. Yan. This type did, in fact, first fly in 1956; several examples have now been built but they have presumably not proved entirely satisfactory, otherwise one might have expected them to have been used by the Polish team.

The new wing is geometrically identical to the earlier one except for its change in section. The tail unit of the Jaskolka L is, however, quite different. It is of the V-type which was tried on an earlier (non-laminar) version of the Jaskolka, the SZD-14X known as the type "M."

The empty equipped weight of the laminar Jaskolka has come out 70 kg. more than the 270 kg. of the standard aircraft and the maximum permissible flying weight has been raised from 455 to 540 kg. At a 7% higher flying weight for the laminar machine (385 as against 360 kg.) the speed for minimum sink is raised 12 k.p.h. and that for maximum L/D by 13 k.p.h. The rate of minimum sink is very slightly increased, while the L/D is slightly improved from 28.5 to 31.2.

The new wing is ply-covered with a much thicker skin which gives a high degree of freedom from waviness as well as a good surface finish. It is interesting that the standard Fowler flaps of the Jaskolka have been dropped for the laminar wing and are replaced by narrow-chord (about 12 cm.) split flaps. These are presumably intended to restore some of the maximum lift coefficient required for landing which has been lost as a result of going to the new section.

Split flaps are standard on the Polish Bocian two-seater, as was noted at St. Yan where the type competed. Although no

(*Continued on page 940*)

TABLE I

POST-WAR POLISH SAILPLANES

(Designed by the Gliding Institute (Instytut Szybownictwa), later renamed the Experimental Glider Establishment (Szybowcowy Zaklad Doswindazatory))

Type	Name	First flight	Designers	Span	Length	Height	Wing area	Aspect ratio	Empty weight	Loaded weight	Wing loading	Best glide ratio		Min. sink		Max. design speed	Wing section		Remarks
				m.	m.	m.	sq. m.		kg.	kg.	kg./sq.m.	L./D.	k.p.h.	m./sec.	k.p.h.	k.p.h.	Root	Tip	
IS.1	Sep	2.6.'47	J. Niespal, W. Nowakowski	17.5	7.5	1.43	17	18	330	410	24	27.5	—	0.7	—	250	Go 549	M.11	Prototype. High-perf. sailplane.
IS.1 bis	Sep bis	1948	J. Niespal, W. Nowakowski	17.5	7.5	1.43	17	18	—	—	—	—	—	—	—	250	Go 549	M.11	Small production. High-perf. sailplane.
IS.2	Mucha	29.4.'48	F. Kotowski, I. Kaniewska	15.0	7.0	1.36	15	15	170	260	17.4	24	70	0.7	47	250	Go 549	M.12	Prototype. Training sailplane (leading-edge dive brakes).
IS.2 bis	Mucha bis	1949	F. Kotowski, I. Kaniewska	15.0	7.0	1.36	15	15	182	290	18.1	24	70	0.7	48	250	Go 549	M.12	Production. Training sailplane (mid-chord dive brakes).
IS.2 ter	Mucha ter	1950	F. Kotowski, I. Kaniewska	15.0	7.0	1.36	15	15	180	290	18.0	23.9	70	0.72	48	250	Go 549	M.12	Production. Training sailplane (mid-chord dive brakes).
IS.3	ABC	Autumn '47	R. Matz, R. Zatwardnicki	9.0	6.0	1.4	13.5	6	70	150	11.1	11	—	1.3	—	145			Prototype. Elementary trainer.
IS.3 bis	ABC bis	—	R. Matz, R. Zatwardnicki	9.0	6.0	1.4	13.5	6	—	—	—	—	—	—	—	145			Production. Elementary trainer.
IS.3 ter	ABC ter	1950	R. Matz, R. Zatwardnicki	9.0	6.0	1.4	13.5	6	—	—	—	—	—	—	—	145			Production. Elementary trainer.
IS.4	Jastrzab	21.12.'49	J. Niespal, W. Janica	12.0	6.0	1.2	12	12	150	280	24	23.5	90	0.85	70	500			Aerobatic sailplane. Small production. Dev. of IS.1.
IS.5	Kaczka	Apl. '49	I. Kaniewska, T. Kostia	11.56	4.0	2.3	11.6	13	120	185	16	21	75	0.93	66	250			Experimental: tail-first design. Flown with and without rudder.
IS.6X	Nietoperz	2.2.'51	J. Sandauer, W. Szybownictwa	12.0	3.94	1.55	14.4	10	—	265	18.4	23	85	—	—	—			Experimental: tailless aircraft.
IS.7	Osa	1950	T. Kostia	15.0	6.8	1.36	14.1	16	237	330	23.2	26.1	75	0.8	56	250	NACA 65₂515	NACA 65₂515	Prototype. Dev. of Mucha.
SZD.8	Jaskolka	1951	T. Kostia	16.0	6.74	1.41	13.6	18.8	—	340	25	28	82	0.74	65	250	NACA 43012A	NACA 43012A	Prototype. High-perf. sailplane.
SZD.8 bis	Jaskolka bis	1952	T. Kostia, J. Sandauer, A. Skarbinski	16.0	7.42	1.41	13.6	18.8	232	330	24.2	27	82	0.75	68	250	NACA 43012A	NACA 43012A	Production. High-perf. sailplane with lengthened fuselage.
SZD.8 bis	Jaskolka W	1954	—	16.0	7.42	1.41	13.6	18.8	—	—	—	—	—	—	—	250	NACA 43012A	NACA 43012A	Production. Water ballast.
SZD.8 ter	Jaskolka ZO	1957	—	16.0	7.42	1.41	13.6	18.8	—	340	25	26.4	80	0.76	68	250	NACA 43012A	NACA 43012A	Production. For export.
SZD.8 ter	Jaskolka Z	1955	T. Kostia, J. Sandauer, S. Wielgas, A. Skarbinski	16.0	7.42	1.41	13.6	18.8	270	455	33.5	28.5	82	0.75	75	250	NACA 43012A	NACA 43012A	Production. Water ballast and radio.
SZD.9	Bocian	11.3.'52	Wasilewski, R. Zatwardnicki, J. Sandauer	18.0	—	1.41	20	16.2	—	450	22.5	22	75	0.75	65	220	NACA 43018A	NACA 43012A	Prototype. Two-seat high-perf. sailplane.
SZD.9 bis	Bocian bis	1954	Wasilewski, R. Zatwardnicki, J. Sandauer	18.0	8.2	1.41	20	16.2	330	500	25	26	82	0.8	72	200	NACA 43018A	NACA 43012A	Production. Two-seat high-perf. sailplane.
SZD.9 bis	Bocian ID	1957	—	18.0	8.2	1.41	20	16.2	—	500	25	26	80	0.82	68	200	NACA 43018A	NACA 43012A	Production. For export.
SZD.9 ter	Bocian Z	Apl. '56	—	18.0	8.2	1.41	20	16.2	—	—	—	—	—	—	—	—			Prototype. Water ballast and wing tip "shapes."
SZD.9	Bocian S	1953	J. Bojanowski, Makaruk	—	—	—	—	—	—	—	—	—	—	—	—	—			Light-weight Bocian.
SZD.10	Czapla	1953	R. Zatwardnicki, I. Kaniewska, M. Gracz	16.0	8.73	—	24.0	10.6	—	420	17.5	17.1	64	0.96	52	—	Go 549	Go 549	Prototype. Two-seat training sailplane.
SZD.10 bis	Czapla bis	1954	R. Zatwardnicki, I. Kaniewska, M. Gracz	16.0	8.73	—	24.0	10.6	280	440	18.4	17	66	1.03	55	160	Go 549	Go 549	Production. Two-seat training sailplane.
SZD.11	Albatross	1956	J. Sandauer	—	7.42	1.41	—	—	—	—	—	—	—	—	—	—			Prototype. Jaskolka with larger wing.
SZD.12	Mucha-100	1953	Okarmus, J. Dyrek, Badura	15.0	7.0	1.36	15	15	195	290	19.3	24	69	0.72	54	210	Go 549	M.12	Production. Improved version of Mucha.
SZD.12A	Mucha-100A	1957	Okarmus, J. Dyrek, Badura	15.0	7.0	1.36	15	15	195	290	19.3	24	70	0.77	50	210	Go 549	M.12	Production. For export.
SZD.13X	Wampir	Not completed		—	—	—	—	—	—	—	—	—	—	—	—	—	laminar sect.		Experimental tailless aircraft. Dev. of IS.6X.
SZD.14X	Jaskolka M	1954	T. Kostia, Okarmus	16.0	6.8	—	13.6	18.8	—	—	—	—	—	—	—	—	NACA 43012A	NACA 43012A	Prototype. Vee tail and water ballast.
SZD.15	Sroka	1956	Badura	—	—	—	—	—	—	—	—	—	—	—	—	—			Prototype. Training sailplane.
SZD.16	Gil	1958	—	—	—	—	—	—	—	—	—	—	—	—	—	—			Prototype. Training sailplane, mixed construction.
SZD.17X	Jaskolka L	1956	T. Kostia, J. Dyrek	16.0	6.8	—	13.6	18.8	340	540	39.8	31.2	95	0.8	87	250	NACA 65₂512A	NACA 65₂515A	Prototype. Vee tail.
SZD.18	Czajka	1957	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
SZD.19X	Zefir	1958	B. Szuba	17.0	7.3	1.27	14	20.6	—	375	26.8	34.1	89	0.69	84	220	laminar sect.		Prototype. High-perf. sailplane, mixed construction.
SZD.20X	Wampir	1958	—	—	—	—	—	—	—	—	—	—	—	—	—	—			Prototype. Dev. of SZD.13X.
SZD.21	—	Details not available																	
SZD.22	Mucha-Standart	10.2.'58	W. Nowakowski, R. Grzywacz	14.98	7.0	1.65	12.75	17.6	220	326	25.1	27.8	75	0.73	59	230	Go 549	M.12	Standard Class dev. of Mucha-100 with new wing and other changes.

Bocians took part in the Championships at Leszno, a number were in evidence. At least one of these machines had had its flaps removed—possibly an indication of their ineffectiveness?

In addition to the Jaskolkas, Mucha-100s and two examples of the new Mucha-Standart, designed to the requirements of the new International Standard Class, took part in the 1958 Championships. The last named did extremely well, being placed first and sixth in the Standard Class final results.

A generally high standard of manufacture and detail design was a feature of all the Polish gliders seen during the writer's visit to Poland. The Jaskolka, Bocian and Mucha, in particular, are quite clearly well designed and built and thoroughly proven production articles. It is always easy to criticize individual design details—for example, the very vulnerable unsealed ball races on the aileron hinges of the Jaskolka, which stick down below the wing tips, seemingly asking for trouble. But even more one is struck by the good features: the universally neat and well-laid-out cockpits, with all controls clearly labelled and identified; the practical cockpit canopies (particularly the sliding type on the Jaskolka and the lifting type on the Mucha-Standart); the sensible, retractable undercarriages (even though the wheels are surprisingly far aft), and the excellent rigging arrangements.

The aft wheel position on the Jaskolka appears to be a growing fashion in Eastern Europe. In this new design practice, the wheel is mounted a considerable distance aft of the aircraft's centre of gravity, in fact so far aft that even the unloaded C.G. is forward of the main point of support and the aircraft always sits in a "sniffing dog" attitude with its nose to the ground and tail bumper in the air. The aft-positioned wheel is associated with a short nose skid which often seems inadequate to meet the pounding it must inevitably receive during a landing on rough ground. It would be interesting to know why wheels are being moved to the rear. Possibly this step may be intended to reduce stresses induced in the fuselage if the tailskid strikes the ground in a tail-down landing or during winch take-offs.

Boris Cijan, the designer of the fabulous Yugoslav Meteor, of which two competed in the Open Class at Leszno, mentioned that trouble had been experienced from this cause with the Meteor despite the fact that the large retractable main wheel is farther back than, ideally, it should be for other reasons. However, there is a larger problem in ensuring adequate strength for small-sectioned booms in pod-and-boom lay-outs of such machines as the Meteor—unless the tail can be kept completely clear of the ground. Cijan has had good cause to study this question: his Orao II of 1950 failed in flight as a result of overstressing of the boom from striking the tail skid on the ground during winch launching.

Table I gives all the information available on the sailplanes designed in Poland since the War. It provides an instructive summary of sailplane design evolution over a period of 11 years in a country where there have been sufficient funds available for a continuous development programme. As will be seen, the Poles are not resting on the laurels they have won with the successful Jaskolka, Mucha and Bocian in service today. A number of new, more advanced designs are under active development. They seem likely to maintain and strengthen Poland's position as one of the World's leading sailplane-producing nations.

TABLE II—DESIGN FEATURES

Type	Flaps	Dive brakes	Undercarriage	Cockpit canopy
IS.1, Sep	Plain	Under surface leading edge	Skid	Removable
IS.2, Mucha	Nil	SZD	Skid, later fixed wheel	Removable
IS.3, ABC	Nil	Nil	Skid	Nil
IS.4, Jastrzab	Nil	SZD	Fixed wheel	Removable
IS.5, Kaczka	Nil	Rear fuselage	Skid	Removable
IS.6X, Nietoperz	Plain	Split ailerons	Skid	Removable
IS.7, Osa	Nil	SZD	Fixed wheel	Removable
SZD.8, Jaskolka	Fowler	SZD	Retractable wheel	Rearward-sliding
SZD.9, Bocian	Split	SZD	Fixed wheel	Rearward-sliding
SZD.10, Czapla	Nil	SZD	Fixed wheel	Sideways-hinging
SZD.11, Albatross		SZD	Retractable wheel	Rearward-sliding
SZD.12, Mucha-100	Nil	SZD	Fixed wheel	Sideways-hinging
SZD.13X, Wampir				
SZD.14X, Jaskolka M	Fowler	SZD	Retractable wheel	Rearward-sliding
SZD.15, Sroka				
SZD.16, Gil	Nil	—	Fixed wheel	
SZD.17X, Jaskolka L	Split	SZD	Retractable wheel	Rearward-sliding
SZD.18, Czajka	Nil	—		Nil
SZD.19X, Zepir	Fowler	—	Retractable wheel	Rearward-hinging
SZD.20X, Wampir				
SZD.22, Mucha-Standart	Nil	SZD	Fixed wheel	Rearward-hinging

Note: SZD is Polish version of DFS dive brake.

Gliding Notes

by Dr. A. E. Slater

FOR THE 1960 World Gliding Championships, the Council of the British Gliding Association has already compiled a "seeded list" from which the British team will be chosen. They are, in alphabetical order: Peter Bisgood (R.A.E. Bedford), George Burton (Surrey Club), Tony Deane-Drummond (Army Club), Ken Fitzroy (R.A.F.), Tony Goodhart and Nicholas Goodhart (both R.N.), Andrew Gough (R.A.F.), David Ince and Dr. Brennig James (both Surrey Club), Michael Kaye (Derbyshire and Lancashire Club), Dan Smith and Geoffrey Stephenson (both London Club), Lorne Welch (Surrey Club), John Williamson (Army Club) and Philip Wills.

The country organizing the Championships should be decided upon early next spring, when the Gliding Commission of the F.A.I. meets. It is likely to be Germany.

Present opinion in Germany, summed up in *Flugwelt*, is that the last two Championships, in France and Poland, set a standard which can be maintained only by using a large-sized aerodrome, so that the Wasserkuppe mountain, where the first international contest was held in 1937, would be quite unsuitable. The same applies to the sites at Klippeneck in the south and Oerlinghausen in the north-west where post-War national championships have been held. Somewhere in south-west Germany is recommended.

As to the date, late spring or early summer is suggested, not only to get the best thermals, but to avoid clashing with the Olympic Games.

AN unexplained thermal in the lee of the Dunstable cement works chimney was seen by H. A. Taylor, of THE AEROPLANE editorial staff, at 15.30 hrs. on December 6. It is unexplained because of the behaviour of the smoke coming out of the chimney, which only rose a short way after emerging and then sank again, less rapidly, to the level of the chimney-top. Where it reached this low point, about 300 yd. to leeward of the chimney, a party of about 20 gulls was circling just below the smoke, apparently in a thermal.

As can be guessed from the behaviour of the smoke, the air was stable; there was some low-lying mist and a clear sky overhead. The wind was very light easterly, there being an anticyclone centred over north-west England. So what was a thermal doing there? The cement factory is one-third of a mile outside the built-up area of Dunstable, alongside the road running north to Houghton Regis. Upwind from the chimney there was open country for more than two miles as far as Leagrave, a suburb of Luton. There are, however, a good many buildings constituting the cement works, round the base of the chimney, and inside the one at the base is a kiln, where a temperature of 2,700° F. is created.

In less stable weather this chimney commonly produces a visible thermal in its smoke, sometimes leading up to a small cumulous cloud, and on two occasions in 1937 Alexander Ivanoff circled in it with a Grunau Baby and climbed at 3 ft./sec. In 1938 I wrote to the manager for details, and he replied that the chimney is 300 ft. high, with an internal diameter of 10 ft. at the top, and the gas, which is "heavily charged with moisture," emerges at about 120,000 cu. ft./min. at a temperature of 300°-350° F.

Assuming that the air in Ivanoff's thermal was going up at 6 ft./sec. and that its cross-section was 250 ft. in diameter, I worked out that 300,000 cu. ft. of air was going up per second at his level, so the original gases must have been diluted 150 times, and the temperature difference between the thermal and its surroundings would have been 1.8° F. or 1° C.

The matter was discussed in *The Sailplane and Glider* for January, 1939, and in the same issue is an account of how Imperial College Gliding Club pilots contacted thermals at Dunstable Downs by watching the behaviour of the smoke coming out of the cement-works' chimney, which was 1¼ miles directly upwind at the time. They found that thermals crossed the intervening distance at the same speed as the cloud shadows; that is, they travelled at the speed of the gradient wind, not the speed of the surface wind, where hot air must have been continually loosed off to feed the moving thermal.

* * *

JUST 50 years ago, on December 23, 1908, appeared the first issue of the journal *Flugsport*, as we are reminded by *Der Flieger*, which, since the demise of *Flugsport* in 1944, can now claim to be the oldest German aviation journal still alive.

Oskar Ursinus, who died in 1952, was founder and editor of *Flugsport*, and used his journal to call together the first German gliding contest on the Wasserkuppe in 1920. This started off a series of 20 annual contests at which most of the major advances in pre-War soaring were made, and Ursinus, with his fortnightly *Flugsport*, provided the spiritual drive behind it all.

He also fostered research into muscle-power flight and flapping wings, and published material on space flight.

Correspondence

From Major P. D. O'Driscoll, D.A.D.P.R.

Flying Record

NEXT February, 656 Squadron, Army Air Corps, will log the completion of 150,000 hours of operational flying. This, we believe, will almost certainly constitute a world record for any comparable squadron over a similar period of time and it is possible that it is an all-time high for any Service squadron.

For the record, the hours are reckoned from July, 1948, when 656 Squadron started flying in support of the Emergency operations in Malaya. All the flying has been done in Auster Mks. 5, 6, 7 and 9.

I should be interested to know if you, or any of your readers, are able to confirm or refute this claim.

Seremban, Malaya. P. D. O'DRISCOLL.

Smoke from Jets

I WAS very interested in the reply, published on October 17, 1958, to Mr. H. C. Bergel's question regarding the cause of smoke. Smoke emission from aviation turbine engines is a subject of considerable interest and concern. THE AEROPLANE, I am sure, desires to provide its readers with information that is technically correct. However, over-simplification in the reply to Mr. Bergel's question resulted in too much generalization to be technically accurate.

Specifically, I am referring to that section of the reply which advises that black smoke is more likely to be caused by the use of wide-cut gasolene as fuel instead of kerosene.

Wide-cut gasolene and kerosene are only generic terms classifying types of fuels. Individual fuels falling within the rather broad limits of each classification can vary considerably with respect to individual properties and characteristics, among which are the smoking tendencies. For example, smoking characteristics of kerosenes, as evaluated by ASTM D-1322 Smoke Point Test, vary from values of below 20 (high smoke) to 35 (light smoke).

The smoking characteristics of fuel are more directly related to the amount and types of hydrocarbons present, such as aromatics and other properties, than whether it is a wide-cut gasolene or kerosene type. It is possible to have kerosene type fuels having greater smoking tendencies than those of the wide-cut type.

As this matter is of considerable concern, it is felt that any misconception on this point should be corrected so that the airlines' freedom of selection of fuels available to them is not placed in jeopardy by airport authorities.

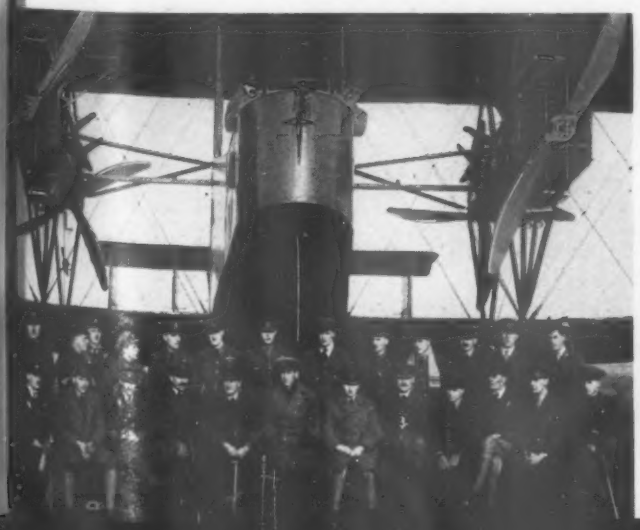
A point of interest in connection with the comments concerning the effect of power augmentation fluid is that current American commercial jet aircraft use pure water, whereas the current British commercial turboprop aircraft are using methanol-water.

Consideration must also be given to the differences in the amount of fuel burned when comparing smoke emission.

New York, U.S.A. ALLEN E. SMITH, Chief Engineer, Aviation Department, Socony Mobil Oil Co., Inc.

To Bomb Berlin—1918

AMONG this year's crop of stories harking back to 1918 I have not myself seen any reference to the then Government's decision that, for the first time, the bombing of civilians by us was to be permitted.



The enclosed photograph shows members of the crews who for many weeks went into training on the East Coast with their objective as Berlin.

These men were practically on the point of taking off when the news came through that the Armistice had been signed. Probably, since feeling ran so high over the raids on Britain, they were the only ones who did not welcome it and their reaction was to get themselves really drunk!

One or two of the men in the smaller group appear faintly familiar to me. I wondered whether they could be recognized and then perhaps somebody could give, for the record, some interesting details of the raid that never was.

London, S.W.20. D. JACKSON (MRS.).

[The aeroplane is one of three Handley Page V/1500 bombers powered by four 375-h.p. Rolls-Royce Eagle VIII engines. They had been assigned to No. 166 Squadron, commanded by Lt.-Col. R. H. Mulock.—ED.]

Wroundabout

"Wroundabout" sends greetings, gratitude and good wishes to readers and supporters who keep us in world-wide and worth-while touch with aviation's lighter side.

*

Shellmanship. Greetings to Hong Kong whence Shell representative Bill Barrington-Mason sends a cutting from the *South China Morning Post* reporting that an airline passenger turned up at the airport there wearing a parachute. When he was told that he couldn't do that there 'ere, he said "Why not?" and nobody could find any regulation against it so he just went right on wearing it. Bill comments: "He knew what he was about, as this operator does not use Shell out of Hong Kong!"

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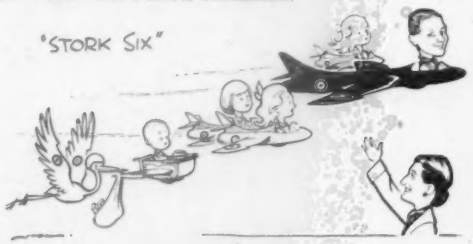
By the seat of somebody else's pants. Greetings to Australia, especially to "Bush" Bandidt, Handley Page representative in Melbourne, who has sent me a story of a very senior Australian captain who was asked how he still kept his licence. "Experience, my boy," he replied. The chap said "What about eyesight—can you still see the ground when you're landing?" The v.s.A.c. said "Good heavens, I don't even look out—I keep an eye on the second Dicky and when he stiffens I pull back the stick!"

*

"Roger—Over. . . ." The end of Sqn. Ldr. Roger Topp's tour as C.O. of No. 111 Sqn. has rather knocked the bottom out of the aerobatic humour-through-pun market. No longer can I write of the "Topp Team" or "Treble One's Perfect Performance." But our best wishes will go with him to Fontainebleau when he joins the Operations Division of Allied Air Forces Central Europe in the New Year.

*

New Boss. Taking over from Roger is Sqn. Ldr. Peter Latham, experienced fighter pilot, ex-C.F.E. At this domestically festive time, let's welcome Peter and Mrs. Peter and their fine family with a sketch of Treble One's latest formation.



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Ways and Means. Upon observing this column's recent surprise at the strange materials used to clean airframe and engine parts (Allison, I pointed out, use crushed walnut shells to clean their turbine blades), a Commander R.N. writes from Scotland to tell of "Soft Grit Black," a cleaner used on both sides of the Atlantic. Queer thing is that in America it is ground apricot seed, whereas the usual British material is pulverized prune stones. In the Commander's opinion our method has the better purgative effect.

by Wrenn

NOTES AND EVENTS

STARTING DEMONSTRATION.—A low-pressure air starting demonstration was recently given to a number of airline representatives at London Airport, when the Auto Diesels, Ltd., Aydee aircraft-starting equipment (model LP 1) was used to start the four JT-3s of a Pan Am Boeing 707. Incorporating a Standard Motor Co. air-bleed turbine, the starting equipment has a rated output under ambient sea-level conditions of 2 lb./sec. at a pressure of 54.7 ± 5 p.s.i.a.

AVIATION LITERATURE. — Mr. C. G. B. Stuart, of Fairlight Hall, Hastings, Sussex, a dealer in old aviation books, has produced a catalogue of rare and out-of-print publications which he has for sale. It is available on request. He would also like to purchase books of this type, particularly volumes of "Jane's All the World's Aircraft," and books on World War I aviation.

FLAW DETECTION.—Kelvin and Hughes has introduced some new additions to its range of ultrasonic flaw-detection equipment. These include flaw detectors Mk. 5F, 5AF and 6, a two-channel flaw alarm for use with the Mk. 5 series of flaw detectors, a Mk. 3 depth and thickness gauge for measuring material thickness from 0.1 in. to 4 in., and a number of receiver/transducer probes.

EPOK RESIN.—British Resin Products, Ltd., has announced that its Epok phenolic resin and glass covering devised for the fan blades used in the Aircraft Research Association, Ltd., transonic wind-tunnel at Bedford has been successful. After a period of two years' operation the covering has remained in good condition in working temperatures of up to 60° C.

CANADIAN MARCONI. — The development of current equipment, together with an increase in research activity, has led to an expansion of staff in the aviation department of the Canadian Marconi Co., Montreal. The company has increased its consultant and after-sales service with the intention of forming closer ties with the aviation and electronic industries.

AIRPORT GENERATORS.—Nine Pelaphone "No-Break" generating plants and associated control gear are being supplied to the New Zealand Government for installation at airports throughout New Zealand. Manufactured by Pelaphone Engines, Ltd., of 38-40 Bruton Street, London, W.1, this type of plant ensures that a continuous power supply is available for airport radar and lighting equipment in the event of mains failure.

JESSOP PRODUCTION. — The vacuum melting plant of William Jessop and Sons, Ltd., which has been used for the production of the Hylite range of titanium alloys and the Vacumelt brand of vacuum-melted steels, is now increasing its scope by the production of Zirconium and its alloys. With a density of 0.233 lb./cu. in. (slightly lighter than steel but heavier than titanium) Zirconium has a useful mechanical strength of the order of 20/25 tons/sq. in.

PRECISION COMPANY.—To further its policy of decentralization and expansion, Automotive Products Associated, Ltd., has formed a new company to be known as Lockheed Precision Products, Ltd. It will manufacture and sell aircraft and industrial hydraulic equipment and Lockheed-Avery hoses and couplings, and will operate from the group's factory at Speke, Liverpool.

Company Notices

NEW COMPANIES

Aircraft Bodies, Ltd. (616,076).—Private co. Reg. Dec. 4. Cap. £6,000 in £1 shs. Directors: Frederick C. Oliver, 256 Main Rd., G'dea Park, Romford; George J. Houghton, 12 Sunninghill Gardens, Eastern Ave., Ilford, directors of Essex Refrigeration Co., Ltd. Sec.: Iris V. Gibbs. Solrs.: Pinney Mummery and Co., Hornchurch. Reg. off.: Airport Works, Riverside, Sutton Rd., Rochford, Essex.

Falcon Airways, Ltd. (616,038).—Private co. Reg. Dec. 3. Cap. £10,000 in £1 shs. Objects: To acquire the business of airline operators carried on by Independent Air Travel, Ltd., at Bournemouth (Hurn) Airport, Christchurch, Hants, as "Falcon Airways," etc. Subscribers (each with one sh.): Henry A. Corsellis, Tudor House, Stansted, Essex, commercial manager; Rosemary Gorle, 56 Stanhope Gardens, London, S.W.7, secretary. First directors to be appointed by subscribers. Sec.: H. A. Corsellis. Reg. off.: 84 Piccadilly, London, W.1.

Trans African Aircoach, Ltd. (615,970).—Private co. Reg. Dec. 2. Cap. £100 in £1 shs. Objects: To establish, maintain, work and carry on lines of aerial communications, etc. Subscribers (each with one sh.): Gerald S. Davis, Victoria House, Bloomsbury Square, London, W.C.1, solicitor; Mabel Vickers, 13 Princes Av., London, N.10, solicitor's clerk. First directors to be appointed by subscribers. Solrs.: Barnett Janner and Co., London, W.C.1. Reg. off.: Victoria House, Bloomsbury Square, London, W.C.1.

Aviation Calendar

December 31. — Kronfeld Club, New Year's Eve Party, at 74 Eccleston Square, **London**, S.W.1.

1959

January 1.—R.Ae.S. Belfast Branch lecture, "Bird Flight," by J. Barlee, in lecture hall LG8, David Keir Building, Queen's University, **Belfast**, at 19.00 hrs.

January 3.—British Interplanetary Society lecture "Rocket Combustion Research with Liquid Propellent Engines," by D. S. Carton (College of Aeronautics), at Caxton Hall, Caxton Street, **London**, S.W.1, at 18.00 hrs.

January 5. — R.Ae.S. Derby Branch, A.G.M. and 10-min. papers, at the Rolls-Royce Welfare Hall, Nightingale Rd., **Derby**, at 18.15 hrs.

January 6.—R.Ae.S. Young People's Lecture, "Rocket Flight in Space," by Dr. L. R. Shepherd, at the Royal Society of Arts, 6 John Adam Street, **London**, W.C.2, at 15.00 hrs.

January 6.—R.Ae.S. Luton Branch lecture, "Flight-testing of Modern Prototype Aircraft," by C. F. Bethwaite (A. V. Roe), in the Napier senior staff canteen, **Luton Airport**, at 18.15 hrs.

January 6. — R.Ae.S. London Airport Branch, film show, at B.E.A.'s Viking Centre Cinema, Hatton Cross, **London Airport**, at 18.00 hrs.

January 7.—R.Ae.S. Brough Branch lecture, "The Tyne Turbo-propeller Engine," by D. McClean (assistant chief designer, Rolls-Royce), in the lecture hall, Electricity Offices, Ferensway, **Hull**, at 19.30 hrs.

January 7.—R.Ae.S. Southampton Branch lecture, "Modern Aircraft Maintenance Procedure and Techniques," by A. G. Nunn (senior planning engineer, B.O.A.C.) in the Institute of Education, University of **Southampton**, at 20.00 hrs.

January 7.—R.Ae.S. Reading Branch lecture, "Interplanetary Flight," by J. E. Simpson, in the Palmer Hall, West Street, **Reading**, at 19.30 hrs.

January 7. — R.Ae.S. Bristol Branch, Brains Trust, at Filton House, **Bristol**, at 18.00 hrs.

January 7.—R.Ae.S. Weybridge Branch, Brains Trust, at the Apprentice Training School, Vickers-Armstrongs (Aircraft), Ltd., Weybridge, at 18.10 hrs.

January 8.—R.Ae.S. Main Lecture, "Safe Mechanisms," by R. Hafner (chief designer, helicopters, Bristol Aircraft, Ltd.), at the Institution of Mechanical Engineers, Birdcage Walk, **London**, S.W.1, at 18.00 hrs.

January 8. — R.Ae.S. Gloucester and Cheltenham Branch lecture, "Guidance and Control," by L. H. Bedford, at St. Mary's College, St. George's Place, **Cheltenham**, at 19.30 hrs.

January 8.—R.Ae.S. Isle of Wight Branch lecture, "The Work of an Air Correspondent," by Angus Macpherson, at the Saunders-Roe Sports and Social Club, Church Path, **East Cowes**, at 18.00 hrs.

January 8.—R.Ae.S. Swindon Branch, A.G.M. and lecture, "Test Flying," by L. R. Colquhoun (Supermarine) at the College, Victoria Road, **Swindon**, at 19.00 hrs.

January 12.—R.Ae.S. Henlow Branch lecture, "Vertical Take-off and Landing," by D. Keith-Lucas (chief designer, Short Bros.), in Building 62, R.A.F. Technical College, **Henlow**, at 19.30 hrs.

New Patents

APPLICATIONS ACCEPTED

808,493.—Fairey Aviation Co., Ltd.—"Aircraft."—Dec. 29, 1955 (Sept. 30, 1954).

808,438.—Cleveland Pneumatic Tool Co.—"Mechanism for controlling the direction of rotation of a rotatable element."—May 10, 1956.

808,608.—Soc. Nationale d'Etude et de Construction de Moteurs d'Aviation.—"Nozzle for jet propulsion units."—May 9, 1957 (May 11, 1956).

Applications open to public inspection on Feb. 4, 1959; opposition period expires on May 4, 1959.